

5.6115-584-34

**ARMY TECHNICAL MANUAL
NAVY PUBLICATION
AIR FORCE TECHNICAL ORDER
MARINE CORPS TECHNICAL MANUAL**

TM 5-6115-584-34
NAVFAC P-8-622-34
TO-35C2-3-456-2
TM-0568C-34

TECHNICAL MANUAL

**INTERMEDIATE (FIELD) (DIRECT AND GENERAL SUPPORT)
AND DEPOT LEVEL MAINTENANCE MANUAL**

GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL SKID MTD 5KW, 1 PHASE
- 2 WIRE, 1 PHASE - 3 WIRE, 3 PHASE - 4 WIRE, 120, 120/240 AND 120/208 VOLTS

DOD MODEL

CLASS

HERTZ

NSN

MEP-002A

UTILITY

60

6115-00-465-1044

This copy is a reprint which includes current
pages from Changes 1 through 4.

PUBLISHED UNDER THE AUTHORITY OF THE DEPARTMENTS OF THE ARMY,
AIR FORCE, NAVY, AND HEADQUARTERS U.S. MARINE CORPS

JULY 1977

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WARNING

All specific cautions and warnings contained in this manual shall be strictly adhered to. Otherwise, severe injury, death and/or damage to the equipment may result.

HIGH VOLTAGE

is produced when this Generator Set is in operation.

DEATH

or severe burns may result if personnel fail to observe safety precautions. Do not operate this Generator Set until the ground terminal stud has been connected to a suitable ground. Disconnect the battery ground cable before removing and installing components on the engine or in the electrical control panel system. Remove all rings, watches, and other jewelry when performing maintenance on this equipment. Loose fitting clothing should be secured to prevent it catching in moving parts. Do not attempt to service or otherwise make any adjustments, connections or recon-nections of wires or cables until Generator Set is shut-down and completely de-energized.

DANGEROUS GASES

Batteries generate explosive gas during charging: therefore, utilize extreme caution, do not smoke, or use open flame in the vicinity of the Generator Set when servicing batteries.

Exhaust discharge contains noxious and deadly fumes. Do not operate Generator Sets in enclosed areas unless exhaust discharge is properly vented to the outside.

To avoid sparking between filler nozzle and fuel tank, always maintain metal to metal contact between filler nozzle and fuel tank when filling fuel tank.

Do not smoke or use open flame in the vicinity of the Generator Set while fueling.

LIQUIDS UNDER HIGH PRESSURE

are generated as a result of operation of the Generator Set. Do not expose any part of the body to a high pressure leak in the fuel injection system.

WARNING

Clean parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Wash exposed skin thoroughly. Dry cleaning solvent (Fed. Spec. P-D-680) used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. to 138° F. (38° C. to 59° C.).

WARNING

If conditions require fuel tank repairs by welding or other methods involving heat or flame, take care to assure that all fumes are purged from the tank or fill tank with water before commencing the repair. If possible, tank should be filled with water prior to welding after being thoroughly purged of fumes. Applying heat or flame to a fuel tank containing residue, may result in a violent explosion, causing death or injury to maintenance personnel.

NOISE

Operating level of this generator can cause hearing damage. Ear protectors, as recommended by the medical or safety officer, must be worn when working near this set.

Army Technical Manual
Navy Publication
Air Force Technical Order
Marine Corps Technical Manual

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No. 4 }

DEPARTMENTS OF THE ARMY NAVY,
AIR FORCE AND MARINE CORPS
WASHINGTON, D.C., 1 April 1986

Intermediate (Field) (Direct and General Support)
and Depot Level Maintenance Manual

GENERATOR SET, DIESEL ENGINE DRIVEN; TACTICAL
SKID MTD 5 KW, 1 PHASE-2 WIRE, 1 PHASE-3 WIRE,
3 PHASE-4 WIRE, 120, 120/140 AND 120/208 VOLTS

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To be distributed in accordance with DA Form 12-25A, Direct and General Support Maintenance requirements for Generator Set, Diesel Driven, Tactical, Skid Mounted, 120V, 120/240V, 120/208V, 5KW, 60HZ, 1PH/2 Wire, 1PH/3 Wire, 3PH/4 Wire (MEP-002A).

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AIR FORCE AND MARINE CORPS
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Marine Corps:

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Intermediate (Field)(Direct and General Support)
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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. SCOPE.

This manual is for your use in maintaining the DOD Standard Generator Set, 5KW Diesel Engine Driven, Model MEP-002A. It contains sections for general maintenance, including troubleshooting, and removal and installation of major components, and maintenance of individual components of the unit. Thoroughly familiarize yourself with the unit before servicing or repairing unit.

1-2. LIMITED APPLICABILITY.

Some portions of this publication are not applicable to all services. These portions are prefixed to indicate the services to which they pertain: (A) for Army, (F) for Air Force, (N) for Navy, and (MC) for Marine Corps. Portions not prefixed are applicable to all services.

1-3. MAINTENANCE FORMS AND RECORDS.

a. (A) Maintenance forms and records used by Army personnel are prescribed in TM 38-750.

b. (F) Maintenance forms and records used by Air Force personnel are prescribed in AFM-66-1 and the applicable 00-20 Series Technical Orders.

c. (N) Navy users should refer to their service peculiar directives to determine applicable maintenance forms and records to be used.

d. (MC) Maintenance forms and records used by Marine Corps personnel are prescribed in TM 4700-15/1.

1-4. REPORTING OF ERRORS.

Report of errors, omissions, and recommendations for improvement of this publication by the individual user is encouraged. Reports should be submitted as follows:

a. (A) Army - DA Form 2028 directly to: Commander, US Army Troop Support Command, ATTN: DRSTS-MPP, 4300 Goodfellow Boulevard, St. Louis, MO 63120.

b. (F) Air Force - AFTO Form 22 directly to: Commander, Sacramento Air Logistics Center, ATTN: MMEDT, McClellan Air Force Base, CA 95652, in accordance with TO-00-5-1.

c. (N) Navy - by letter directly to: Commanding Officer, US Navy, Ships Parts Control Center, ATTN: Code 783, Mechanicsburg, PA 17055.

d. (MC) Marine Corps - by NAVMC form 10772 directly to: Commandant, US Marine Corps, ATTN: Code LMO-1, WASH DC 20380.

1-5. LEVELS OF MAINTENANCE ACCOMPLISHMENT.

a. (A, MC) Army and Marine Corps users shall refer to the Maintenance Allocation Chart (MAC) for tasks and levels of maintenance to be performed.

b. (F) Air Force users shall accomplish maintenance at the user level consistent with their capability in accordance with policies established in AFM 66-1.

c. (N) Navy users shall determine their maintenance levels in accordance with their service directives.

Section II. DESCRIPTION AND TABULATED DATA

1-6. DESCRIPTION.

A general description of the Diesel Engine Generator Sets and information pertaining to the identification plates are contained in the Operator and Organizational Maintenance Manual. Detailed descriptions of the components of the Diesel Engine Generator Sets are provided in the applicable maintenance paragraphs of this manual.

1-7. TABULATED DATA.

a. General. This paragraph contains all maintenance data pertinent to intermediate (field) (direct, general support) and depot maintenance personnel.

b. Engine Generator Sets. Refer to Operator and Organizational Maintenance Manual.

1-2

Table 1-1. Torque Values (Ft-Lb)

Item	Torque Range (Cadmium Plated) (Ft-Lb)	
	Min.	Max.
Connecting rod bolt	27	29
Cover-rocker box	7	8
Exhaust manifold nuts	11*	13*
Flywheel mounting screw	54	58
Gearcase cover	15	17
Rear bearing plate	40**	45**
Rocker arm nut (prevailing torque locknut)	4***	10***
Rocker arm stud	35	40
Oil pump mounting screws	13	17
Oil base mounting screws	42****	47****
Oil filter base mounting screws	18	20
Cylinder head bolt	44*	46*
Oil cooler mounting screws (with clips)	20	22
Blower wheel mounting screw	65	70
Intake manifold mounting screws	13	15
Injector nozzle mounting screws	17	18
Glow plug	10*	15*
Governor arm locking screw	32 (in. lb.)	36 (in. lb.)
Damper blower wheel assembly nut	28	30
Backplate screw (hex-socket flathead)	75 (in. lb.)	85 (in. lb.)
Center main bolt	97	102
High temperature cutout switch	50 (in. lb.)	60 (in. lb.)
Fuel supply line nut	16	18
Fuel return line flare fitting*****		
*Anti Seize Compound. **Apply MIL-S-22473C, Grade CV, to threads ***Torque specifications to be used only to determine if used locknuts meet new part tolerances. ****Torque these screws twice. *****Tighten fuel return line to 1/6 turn beyond a hand tightened snug fit.		

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Table 1-2. Repair and Replacement Standards
 (All values in inches unless otherwise specified.)

Component	Manufacturer Dimensions and Tolerances		Maximum Allowable Wear Limit
	Minimum	Maximum	
CYLINDER BLOCK:			
Cylinder bore diameter	3.4993	3.5005	0.005
Cylinder bore out of round		0.001	0.001
Cylinder bore taper		0.001	0.002
Main bearing bore - less bearings	2.4365	2.4375	2.4375
Camshaft bearing bore - less bearings			
Front	2.3745	2.3755	2.3755
Rear	1.3120	1.3130	1.3130
Valve tappet bore	0.8755	0.8765	0.8775
CRANKSHAFT:			
Main bearing journal diameter	2.2427	2.2435	0.001
Main bearing journal clearance	0.0012	0.0037	0.0047
Main bearing journal out of round		0.0005	0.001
Main bearing journal taper		0.0004	0.0015
Connecting rod journal diameter	2.0597	2.0605	0.002
Connecting rod journal out of round		0.0005	0.001
Connecting rod journal taper		0.0004	0.0015
Fillet radii	0.1100	0.1200	0.1200
*Crankshaft main bearing clearance	0.0024	0.0049	0.0054
Crankshaft thrust clearance	0.010	0.015	0.015**
Seal surface diameter - rear	1.8740	1.8750	0.0050
Seal surface diameter - front	1.6870	1.6875	0.0050
CONNECTING ROD:			
Length - c to c	5.9980	6.002	6.002
Bearing bore - less bearings	2.1871	2.1876	2.1886
Bearing to crankshaft clearance	0.0010	0.0030	0.0040
Connecting rod side clearance	0.0020	0.0160	0.0160
* Replacement Bearing Only ** Shim Controlled			

Table 1-2. Repair and Replacement Standards (Cont)

Component	Manufacturer Dimensions and Tolerances		Maximum Allowable Wear Limit
	Minimum	Maximum	
CONNECTING ROD (Cont):			
Connecting rod side clearance	0.0020	0.0160	0.0160
Piston pin bushing bore - less bushing	1.043	1.045	1.0455
Piston pin bushing bore	0.9903	0.9906	0.001
CAMSHAFT:			
Bearing journal diameter			
Front	2.2500	2.2505	0.002
Rear	1.1875	1.1880	0.002
Lobe diameter - base to tip	1.185	1.189	0.005
Journal runout in vee blocks			0.004
Bearing clearance	0.0012	0.0037	0.0057
End Thrust	0.0070	0.0390	0.0450
Backlash camshaft to crank gear	0.005	0.0100	0.0120
PISTON:			
Clearance in cylinder bore (pull on 1/2 x 0.0050 ribbon)	0.0062	0.0082	0.010
Piston pin bore	0.99005	0.99025	0.9903
Width of ring groove - top	0.097	0.098	0.005
Width of ring groove - 2nd & 3rd compression	0.0965	0.0975	0.005
Width of ring groove - oil control	0.1880	0.1895	0.005
PISTON PIN:			
Length	2.988	3.003	N/A
Diameter	0.9899	0.9901	0.001
Clearance in piston	0.0005	0.0025	0.0003
Clearance in connecting rod	0.0002	0.0007	0.0008
PISTON RING:			
Clearance in groove - top	0.0035	0.0075	0.0100
Clearance in groove - 2nd & 3rd compression	0.0030	0.0050	0.0080

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Table 1-2. Repair and Replacement Standards (Cont)

Component	Manufacturer Dimensions and Tolerances		Maximum Allowable Wear Limit
	Minimum	Maximum	
PISTON RING (Cont):			
Clearance in groove - oil control	0.0020	0.0030	0.0050
Gap	0.0100	0.0200	0.0400
VALVE, INTAKE:			
Head diameter	1.307	1.317	N/A
Stem diameter - tapered	0.3391/0.3381	0.3420/0.3410	0.002
Stem to guide clearance	0.0030/0.0050	0.0012/0.0032	0.0100
Stem to rocker arm clearance	Cold 0.010		0.010 adjustable
Seat diameter in head	1.361	1.362	N/A
Seat width in head	1/16	3/32	1/8
Top of valve recessed below cylinder head deck	0.433	0.439	0.500
Valve seat angle	45°	N/A	45°
Valve Face Angle	44°	N/A	44°
VALVE, EXHAUST:			
Head diameter	1.307	1.317	N/A
Stem diameter	0.3405	0.3415	0.002
Stem to guide clearance	0.0030	0.0050	0.0100
Stem to rocker arm clearance	Cold 0.007		0.007 adjustable
Seat diameter in head	1.361	1.362	N/A
Seat width in head	3/64	1/16	1/8
Top of valve recessed below cylinder head deck	0.433	0.439	0.500
Valve seat angle	45°	N/A	45°
Valve Face Angle	45°	N/A	45°
VALVE GUIDE:			
Length	Exhaust Intake		
	2 1-25/32		
Outside diameter	0.4690	0.4695	0.4695
Bore diameter - intake - ream	0.3425	0.3435	0.003
Bore diameter - exhaust - ream	0.3445	0.3455	0.003
Height above cylinder head deck	Intake Exhaust		
	11/32 5/8		N/A N/A

Table 1-2. Repair and Replacement Standards (Cont)

Component	Manufacturer Dimensions and Tolerances		Maximum Allowable Wear Limit
	Minimum	Maximum	
VALVE LIFTER:			
Body diameter	0.8725	0.8730	0.003
Overall length	1.510	1.550	1.500
Clearance in bore (block)	0.0025	0.0040	0.008
VALVE SPRINGS - INTAKE & EXHAUST:			
Free length	1-7/8		
Total coils	5.75		
Diameter wire	0.142		
Outside diameter	0.901	0.920	
Load closed	45 lb	49 lb	40 lb
Load open	87.2 lb	97.2 lb	80 lb
OIL PUMP BODY:			
Shaft bore diameter - main	0.368	0.343	0.002
Shaft bore diameter - idler	0.308	0.309	0.002
Pump gear bore diameter	0.884	0.886	0.003
Pump gear bore depth	0.748	0.750	0.002
OIL PUMP SHAFTS:			
Length - main	1.176	1.206	N/A
Length - idler	1-1/16		N/A
Diameter - main	0.3124	0.3126	0.002
Diameter - idler	0.3095	0.3110	0.002
Shaft clearance in body	0.0009	0.0016	0.003
OIL PUMP GEARS:			
Outside diameter - both	0.878	0.880	0.005
Length - both	0.749	0.750	
Clearance in body bore	0.004	0.008	
End clearance to body	Shimmed		
Backlash, drive gear to camshaft	0.005	0.010	adjustable

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Table 1-2. Repair and Replacement Standards (Cont)

Component	Manufacturer Dimensions and Tolerances		Maximum Allowable Wear Limit
	Minimum	Maximum	
FLYWHEEL:			
Face runout, total		0.0053	
Pilot bore eccentricity		0.0020	
FLYWHEEL HOUSING:			
Attaching face deviation		0.0113	
Housing bore eccentricity		0.005	
ROCKER ARM MECHANISM:			
Tappet adjusting screw torque	4 ft-lbs	10 ft-lbs	
CYLINDER HEAD:			
Warpage (longitudinally)		0.001	0.0015
Warpage (laterally)		0.001	0.0015

(7) Oil Cooler. Refer to Operator and Organizational Maintenance Manual.

1. Safety Devices.

(1) High temperature switch. Refer to Operator and Organizational Maintenance Manual.

(2) Low oil pressure switch. Refer to Operator and Organizational Maintenance Manual.

(3) Fuel level switch (day tank). Refer to Operator and Organizational Maintenance Manual.

m. Engine Repair and Replacement Standards. Table 1-2 lists manufacturer's sizes, tolerances, and maximum allowable wear and clearances.

n. Schematic Wiring Diagrams. Figure 1-1 shows the schematic wiring diagram of the power plant.

o. Torque Values.

(1) Table 1-1 lists specific torque values.

(2) All torque values are calculated for oil lubricated threads. Increase this value by 10 percent when threads are not lubricated.

Charts Transposed to

End of Volume.

CHAPTER 2

GENERAL MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS, TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE), AND SUPPORT EQUIPMENT

2-1. REPAIR PARTS.

Repair parts and equipment are listed and illustrated in the repair parts and special tools list manual covering intermediate (field) (Direct and General Support) and depot maintenance for this Generator Set.

2-2. TOOLS AND EQUIPMENT.

Table 2-1 contains a list of all special tools, test and support equipment needed to maintain this unit.

2-3. FABRICATED TOOLS AND EQUIPMENT.

Table 2-2 contains fabrication instructions for all tools which must be fabricated by intermediate or depot personnel for maintenance of this unit.

Table 2-1. Special Tools, Test and Support Equipment

Item	NSN Reference No.	Reference		Use	Table No.
		Fig. No.	Para. No.		
Delivery valve test fixture	(01843)* TSE-76226 or equivalent	7-36	7-18	Testing fuel injection pump delivery valve	2-2
Pump mounting fixture			7-18	Mount fuel injection pump in vise for disassembly	
Plunger spring compression tool	TSE-76215	7-35	7-18	Remove and install spring seat	
Centering sleeve	TSE-773	7-47	7-20	Assembly of fuel injector	
Compressor tester gage	4910-00-870- 6283	7-8.1	7-8.1	Test engine compressor	
Compression adapter	4910-00-870- 2127	7-8.1	7-8.1	Test engine compressor	
* Federal supply code for the manufacturer.					

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Table 2-2. Fabricated Tools and Equipment

Nomenclature	Reference No. or NSN	Material Required
Pump mounting fixture		0.375" cold rolled steel

Fabrication Instructions:

Fabricate fixture as shown below. Drill "F" (0.255 in. - 0.262 in.) depth thru countersink 60° incl. to 0.332 in. diameter. Tap 0.3125-18 UNC-2B depth thru. Two holes located within 0.005 in. of true position.

Sketch or Diagram:

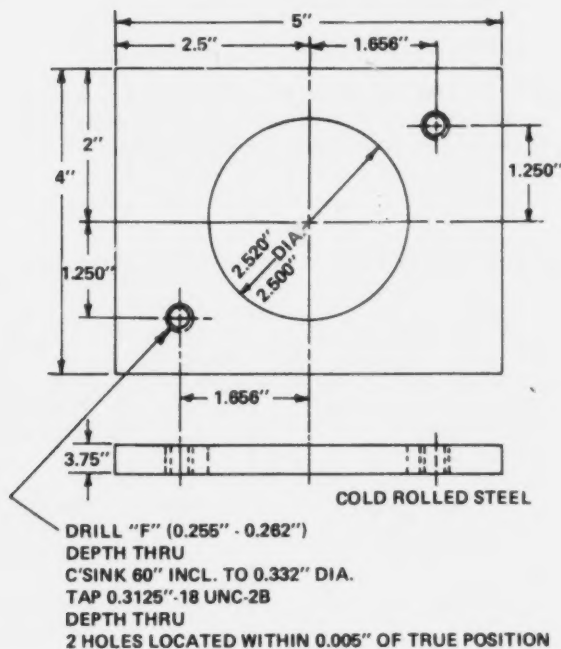


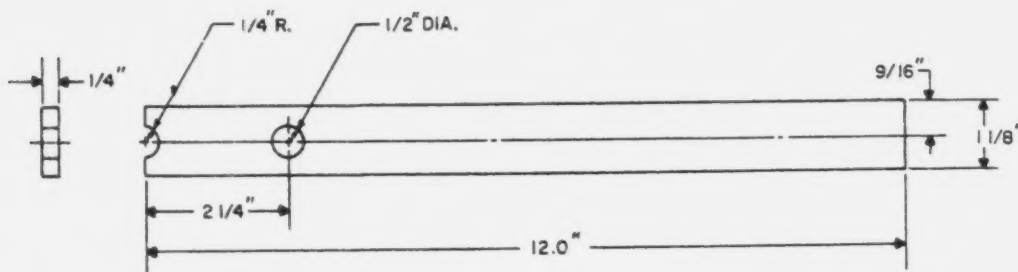
Table 2-2. Fabricated Tools and Equipment (Cont)

Nomenclature	Reference No. or NSN	Material Required
Valve spring depressor		1/4" cold rolled steel

Fabrication Instructions:

Fabricate tool to dimensions shown below.

Sketch or Diagram:

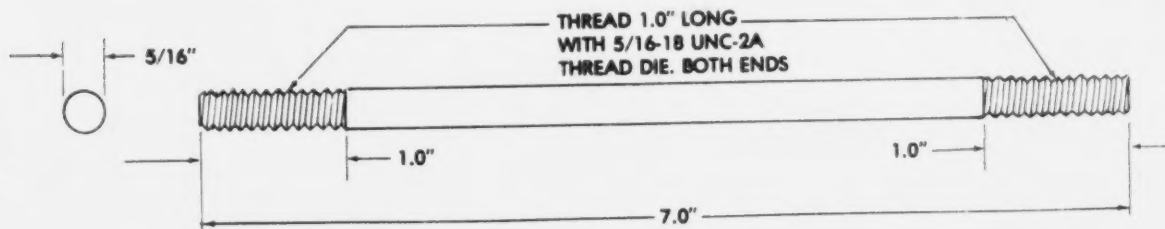


Nomenclature	Reference No. or NSN	Material Required
Compression adapter mounting studs		5/16" cold rolled steel

Fabrication Instructions:

Fabricate compression adapter mounting studs (2 required) to the dimensions shown below.

Sketch or Diagram:



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Table 2-2. Fabricated Tools and Equipment (Cont)

Nomenclature	Reference No. or NSN	Material Required
Crankshaft gear driver		Steel pipe 3/16" wall thickness

Fabrication Instructions:

Fabricate tool to dimensions shown below by sawing pipe to correct length.

Sketch or Diagram:

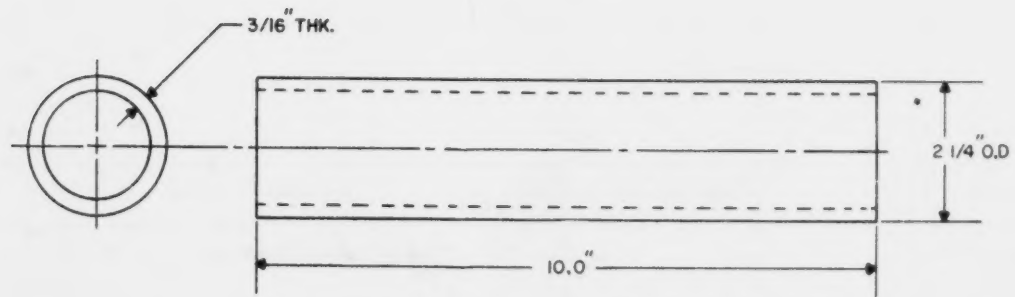


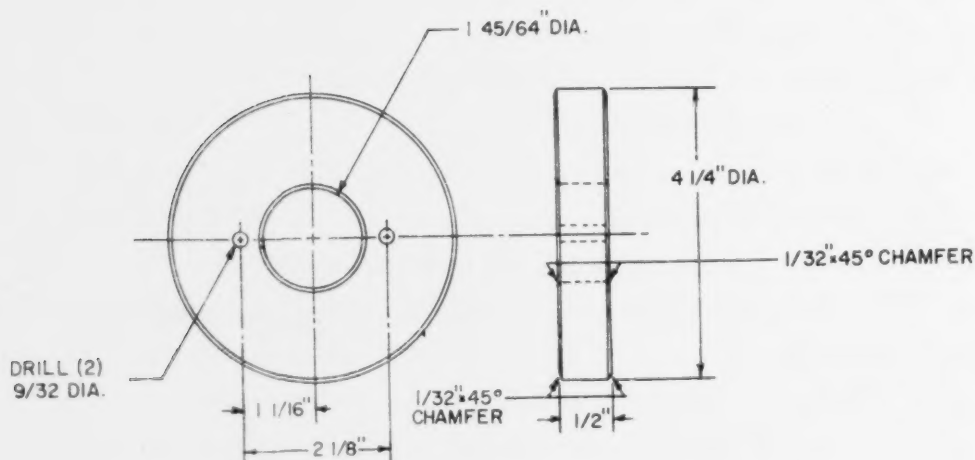
Table 2-2. Fabricated Tools and Equipment (Cont)

Nomenclature	Reference No. or NSN	Material Required
Crankshaft gear puller ring		Steel, round, CD

Fabrication Instructions:

Make puller according to dimensions shown below.

Sketch or Diagram:



Section II. TROUBLESHOOTING

2-4. GENERAL.

This section contains troubleshooting information for locating and correcting operating troubles which may develop in the Generator Set. Each malfunction for an individual component unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. You should perform the tests/inspections and corrective actions in the order listed.

2-5. MALFUNCTIONS NOT CORRECTED BY USE OF THE TROUBLESHOOTING TABLE.

This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or cannot be corrected by listed corrective actions, notify your supervisor.

Table 2-3. Troubleshooting

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
1. STARTER MOTOR DOES NOT TURN-HIGH CURRENT DRAW.		
	Step 1. Check starter for grounded switch, terminals, or field (paragraph 5-2).	Replace any grounded component.
	Step 2. Check for frozen armature shaft bushing (paragraph 5-2).	Replace bushing and, if necessary, armature.
2. STARTER DOES NOT TURN-NO CURRENT DRAW.		
	Step 1. Check for open armature windings (paragraph 5-2).	Replace armature if necessary.
	Step 2. Check for open starter field windings (paragraph 5-2).	Replace field windings if necessary.
	Step 3. Check for broken or weak brush springs (paragraph 5-2).	Replace brush springs if necessary.
	Step 4. Check for worn commutator (high mica) (paragraph 5-2).	Refinish commutator or replace armature (including commutator).
3. SLOW STARTER SPEED.		
	Step 1. Check for dirty commutator (paragraph 5-2).	Clean or refinish commutator.
	Step 2. Check for worn armature shaft bushings (paragraph 5-2).	Replace bushings and, if necessary, armature.
	Step 3. Check for burned solenoid contacts (paragraph 5-2).	Replace solenoid.
	Step 4. Check for open or shorted starter field windings (paragraph 5-2).	Replace windings if necessary.
	Step 5. Check for shorted generator stator windings (paragraph 8-2).	Replace stator windings.
	Step 6. Check for worn generator end bearing (paragraph 8-2).	Replace bearing if necessary.
	Step 7. Check for worn engine crankshaft, rod, and camshaft bearings (paragraph 7-17).	Replace bearings as necessary. Repair or replace other worn components as necessary.

Table 2-3. Troubleshooting (Cont)

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
4. STARTER WILL NOT ENGAGE FLYWHEEL.		
	Step 1. Check starter clutch (bendix) and pinion (paragraph 5-2).	Repair or replace as necessary.
	Step 2. Check for damaged ring gear (paragraph 7-4).	Replace ring gear if necessary.
5. ENGINE WILL NOT START WHEN CRANKED.		
	Step 1. Check for faulty injection caused by dirty fuel.	Replace with clean fuel. Service fuel filters. Clean and if necessary repair or replace fuel injection nozzle (paragraph 7-20).
	Step 2. Check for poor compression.	See malfunction 14.
	Step 3. Incorrect timing.	Retime engine (paragraph 7-18).
6. ENGINE MISFIRES.		
	Step 1. Check for poor compression.	See malfunction 14.
	Step 2. Check for defective or dirty injection nozzles (paragraph 7-20).	Clean or replace nozzles.
	Step 3. Check for broken valve spring (paragraph 7-9).	Replace broken springs.
	Step 4. Check cylinder head assembly for build-up of carbon (paragraph 7-9).	Clean carbon from cylinder head assembly.
7. LOW ENGINE POWER.		
	Step 1. Check for poor compression.	See malfunction 14.
	Step 2. Check for incorrect timing.	Adjust injection timing if necessary (paragraph 7-18).
8. LOW OIL PRESSURE.		
	Step 1. Check to see if oil by-pass is stuck open (paragraph 7-13).	Clean or replace oil by-pass valve and spring.

Table 2-3. Troubleshooting (Cont)

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
8. LOW OIL PRESSURE (CONT).		
	Step 2. Check for worn oil pump (paragraph 7-11).	Replace pump.
	Step 3. Check for worn engine bearings (paragraph 7-17).	Replace worn bearings.
9. HIGH OIL PRESSURE		
	Step 1. Check to see if oil by-pass is stuck closed (paragraph 7-13).	Clean or replace oil by-pass valve and spring.
	Step 2. Check for clogged oil passages.	Clean all oil lines and passages.
10. EXCESSIVE OIL CONSUMPTION.		
	Step 1. Check for worn valve guides (paragraph 7-9).	Replace guides, valves, and seals.
	Step 2. Check for worn or sticking piston rings (paragraph 7-10).	Replace rings if necessary.
	Step 3. Check for air leaks to crankcase.	Replace gaskets and seals as necessary.
11. BLACK SMOKEY EXHAUST AND EXCESSIVE FUEL CONSUMPTION		
	Step 1. Check for incorrect timing (paragraph 7-18).	Adjust injection timing if necessary.
	Step 2. Check for faulty injection pump or nozzles (paragraphs 7-18 and 7-20).	Repair, overhaul, rebuild, or replace pump and nozzles as necessary.
	Step 3. Check valve condition (paragraph 7-9).	Replace worn valves.
12. TAPPING OR CLICKING SOUND FROM CYLINDER HEAD.		
	Step 1. Check for too great a valve clearance (paragraph 7-9).	Adjust clearance.
	Step 2. Check for broken valve spring (paragraph 7-9).	Replace broken springs.

Table 2-3. Troubleshooting (Cont)

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
13. METALLIC KNOCKING, CLICKING, OR POUNDING FROM CRANKCASE OR CYLINDER BLOCK.		
	Step 1. Check for worn or loose connecting rod bearings (paragraph 7-10).	Replace bearings if necessary.
	Step 2. Check for loose piston and connecting rod assembly (paragraph 7-10).	Repair or replace assembly.
14. LOW ENGINE COMPRESSION.		
NOTE		
Normal cylinder pressure is between 350 and 450 psi depending upon engine condition. Maintenance should be considered if pressure is below 325 psi or if there is a 15 percent or more difference between cylinders.		
	Step 1. Check for loose cylinder head (paragraph 7-9).	Properly tighten head.
	Step 2. Check for leaky head gasket (paragraph 7-9).	Replace gasket.
	Step 3. Check for broken valve spring (paragraph 7-9).	Replace broken springs.
	Step 4. Check for sticking valves (paragraph 7-9).	See sticking valve section below.
	Step 5. Check for leaking valves (paragraph 7-9).	Clean and, if necessary, regrind valves and valve seats.
	Step 6. Check for worn or sticking piston rings (paragraph 7-10).	Replace rings if necessary. Check condition of cylinder walls.
	Step 7. Check for worn cylinder walls and pistons (paragraphs 7-10 and 7-19).	Refinish cylinder walls. Repair or replace pistons.
15. STICKING VALVES.		
	Step 1. Check for dirty, scored, or gummy valve stems or guides (paragraph 7-9).	Clean stems and guides. If necessary, replace guides.
	Step 2. Check for weak or broken springs (paragraph 7-9).	Replace springs.

Table 2-3. Troubleshooting (Cont)

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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15. STICKING VALVES (CONT).

Step 3. Check clearance between valve stem and guide (paragraph 7-9).

Correct clearance.

16. ENGINE RUNS NORMALLY BUT GENERATOR HAS NO OUTPUT.

Step 1. Check voltage regulator (paragraph 6-6).

Repair or replace regulator.

Step 2. Check exciter field (stator) for open or shorted windings (paragraph 8-2).

Replace stator if necessary.

Step 3. Check diodes on exciter rotor (paragraph 8-2).

Replace diodes if necessary.

Step 4. Check generator field (rotor) for open or shorted windings (paragraph 8-2).

Replace rotor if necessary.

Step 5. Check generator rotor flashing circuit (paragraph 6-9).

Replace diode CR2 or bridge rectifier.

Step 6. Check generator stator for open, shorted, or grounded windings (paragraph 8-2).

Replace stator if necessary.

Step 7. Check exciter rotor for open, shorted, or grounded windings (paragraph 8-2).

Replace exciter rotor if necessary.

Step 8. Check bridge assembly A4 for defective resistor or diodes (paragraph 6-9).

Replace defective resistor or diodes

17. ENGINE RUNS NORMALLY BUT GENERATOR HAS LOW OUTPUT.

Step 1. Check voltage regulator (paragraph 6-6).

Adjust, repair, or replace regulator.

Step 2. Check generator stator for open or shorted windings (paragraph 8-2).

Replace stator.

Step 3. Check exciter rotor for shorted windings (paragraph 8-2).

Replace rotor.

Step 4. Check diodes on exciter rotor (paragraph 8-2).

Replace diodes as necessary.

Table 2-3. Troubleshooting (Cont)

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
18. HIGH GENERATOR OUTPUT VOLTAGE (NO LOAD).		
Step 1.	Check for voltage regulator failure. Remove voltage regulator lead if voltage goes even higher, the voltage regulator is good (paragraph 6-6).	Repair defective regulator.
Step 2.	Check voltage adjust rheostat (R1).	Replace rheostat (R1) if necessary.
19. FREQUENCY METER (M3) FAILS TO REGISTER.		
Step 1.	Check transformers T1 and T2 (paragraph 6-4).	Replace bad transformers.
Step 2.	Check frequency meter and transducer (paragraph 6-4).	Replace bad meter or transducer.
20. BATTERIES DO NOT CHARGE.		
Step 1.	Check battery charging alternator stator (paragraph 8-2).	Replace bad stator.
Step 2.	Check battery charging alternator rotor (paragraph 8-2).	Replace bad rotor.
Step 3.	Check regulator-rectifier assembly.	Replace bad regulator-rectifier.
Step 4.	Check DC control windings in the CVT (paragraph 6-9).	Replace if circuit is open.

Section III. GENERAL MAINTENANCE

2-6. GENERAL MAINTENANCE.

This section contains general maintenance instructions which are the responsibility of direct support and general support maintenance personnel. You will find that these instructions apply to several assemblies or components. They would otherwise have to be repeated throughout the chapter.

2-7. GENERAL MAINTENANCE PROCEDURES.

a. Work Guidelines.

(1) Make sure the work area is clean before you disassemble the pump or engine.

(2) Make sure that materials needed for the maintenance task are at hand. These may include cleaning solvents, lubricants, buckets, or other containers for cleaning or keeping components separated, clean wiping cloths, and, of utmost importance, the proper tools.

WARNING

DRY CLEANING SOLVENT, P-D-680 or P-S-861, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. DO NOT use near open flame or excessive heat. Flash point of solvent is 100° to 138° F (38° to 60° C).

(3) Clean the exterior of the engine and pump before disassembly to keep foreign matter from bearings, gears, and other machine-surfaced parts which are subject to scoring and other such damage. Use a cloth dampened with cleaning solvent (fed. spec. P-D-680).

WARNING

Compressed air used for cleaning and drying purposes can create airborne particles that may enter the eyes. Pressure shall not exceed 30 psi and use only with adequate chip guards and goggles.

(4) If compressed air is used to clean parts, you should make sure it is free of dirt and other contaminants.

(5) Protect disassembled parts from dust, blowing sand, and moisture which can cause rapid wear and deterioration of bearings, gears, and other machine parts.

b. Seals and Gaskets. Replace seals and gaskets of all components disassembled. This will greatly reduce the possibility of leaking and will help prevent the entry of dust and dirt after reassembly.

c. Care of Bearings.

(1) Clean ball and roller bearings by placing them in a wire basket and immersing in a container of fresh cleaning solvent. Agitate the bearings in the solvent to remove all traces of old lubricant.

(2) After cleaning the bearings, dry them with clean compressed air. Take care to prevent spinning the bearings when using a compressed air jet.

(3) Dip the cleaned bearings in clean engine oil and immediately wrap them in lint-free paper to protect them from dust and other foreign matter.

d. Replacing Electronic Components.

(1) Tag wires before removal to facilitate proper reconnection.

(2) When soldering use heat sink between soldering pencil and electronic component to prevent damage to the component.

(3) Do not use excessive heat when soldering on printed circuit boards to prevent damage to board.

e. Fuel System Maintenance. The fuel injectors and fuel pump are manufactured to extremely tight tolerances. Even small amounts of dust or water in the fuel system can damage these components. Consequently it is of great importance that dirt be kept out of the fuel lines and fittings during disassembly and assembly. All openings should be taped, plugged, or capped immediately after disassembly. If dirt does accidentally enter a component, it should be washed in clean fuel oil before reassembly.

Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS

2-8. CONTROL CUBICLE.

a. Removal. Refer to Operator and Organizational Maintenance Manual.

b. Installation. Refer to Operator and Organizational Maintenance Manual.

2-9. ENGINE ASSEMBLY.

a. Remove. Refer to the Operator and Organizational Maintenance Manual and perform the following steps.

(1) Disconnect and remove batteries.

(2) Tag and disconnect battery cables and ground cable from starter.

(3) Tag and disconnect wiring harness and electrical leads from engine.

(4) Disconnect air cleaner hoses from shutter assembly and intake manifold. Remove air cleaner and bracket assembly from top of generator.

(5) Disconnect fuel line from fuel filter at fuel check valve. Disconnect flexible fuel return line to top of fuel injection pump.

(6) Disconnect oil drain hose from mounting on skid-base and drain oil.

(7) Disconnect and remove fuel tank.

(8) Disconnect speed adjustment assembly (see figure 2-1). Loosen nut (1) and lockwasher (2) and slide from bracket (5).

(9) Connect a suitable lifting device and support engine.

(10) Disconnect engine from generator assembly. See figure 2-2.

(a) Remove generator screen-guard. Refer to Operator and Organizational Maintenance Manual.

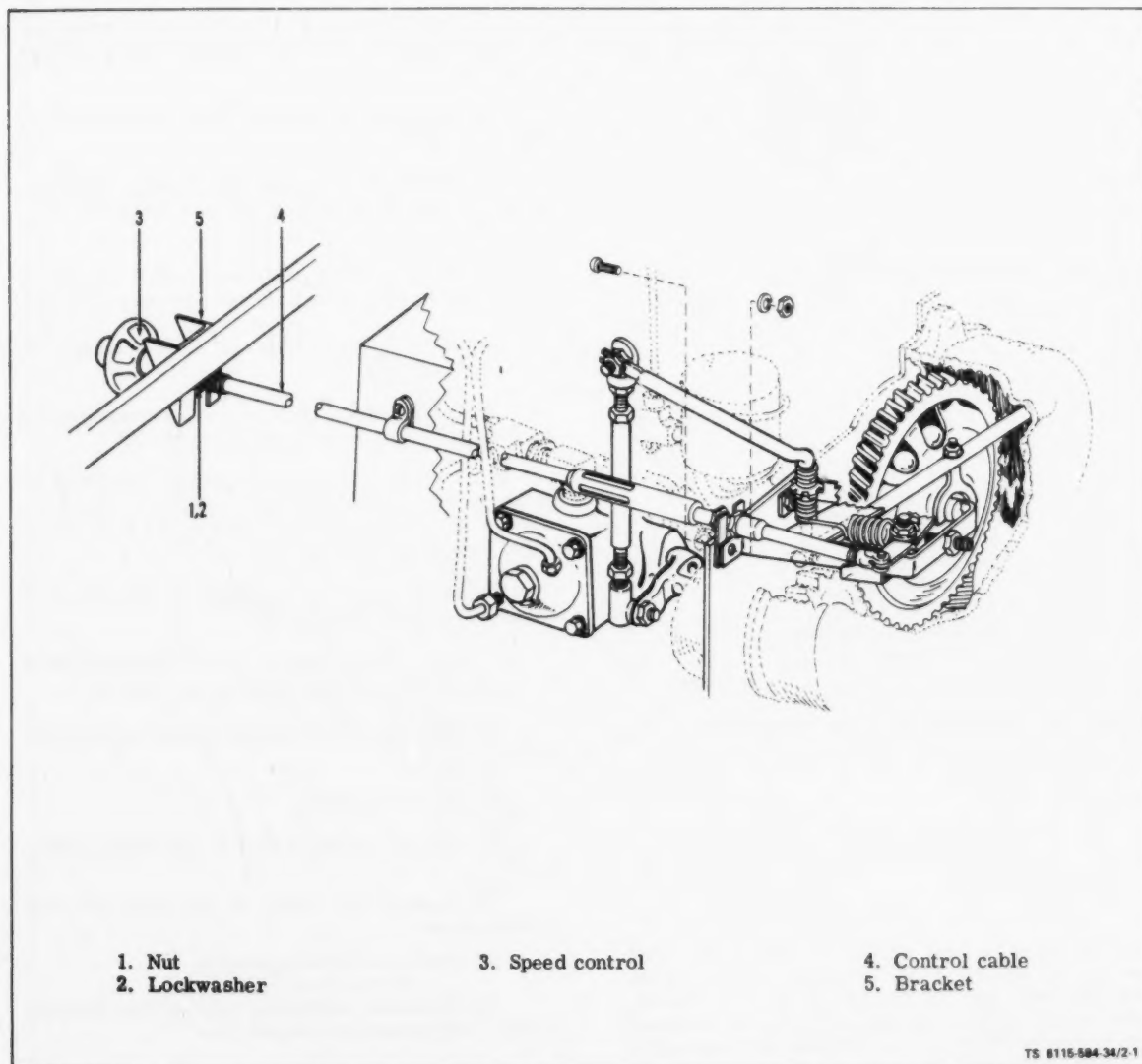


Figure 2-1. Speed Control Assembly

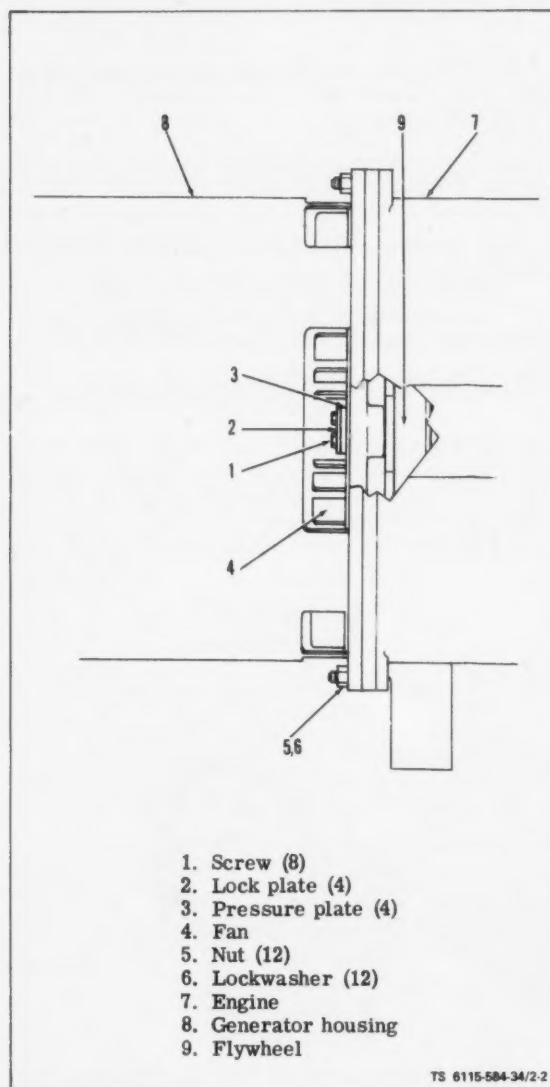


Figure 2-2. Disconnecting Engine from Generator

(b) Remove center plug from grille on blower housing. Refer to Operator and Organizational Maintenance Manual.

(c) Using a 5/8" socket wrench on hex head capscrew at center of blower wheel, rotate engine clockwise until one of the four sets of screws (1, figure 2-2) attaching generator fan (4) and coupling plate to engine flywheel is accessible thru opening in generator housing (8). Straighten locking tabs and remove the two screws (1) and the locking plate (2) and pressure plate (3).

(d) Rotate engine an additional 90° and remove second set of screws. Continue until all four sets of screws (1) are removed.

(e) Remove twelve nuts (5) and lockwashers (6) attaching generator housing (8) to engine (7).

(11) Remove four screws (3, figure 2-3), lockwashers (5), flatwashers (4) and nuts (6) attaching each engine mount (2) to skid-base (7). Lift engine free of Generator Set.

b. Installing Engine-Generator Assembly.

(1) Attach generator to engine.

(a) Install two 1/4-20 x 2 in. pilot studs into the engine flywheel (9, figure 2-2) in two holes that are 180° apart.

(b) Align fan (4), adapter plate and flywheel (9) using pilot studs.

(c) Install four screws (1), locking plate (2), pressure plate (3) attaching fan and adapter to flywheel (9).

(d) Remove pilot studs and install remaining screws (1), locking plates (2) and pressure plate (3).

(e) Bend locking plates (2) to lock all screws (1).

(f) Install twelve nuts (5) and lockwashers (6) to attach generator housing (8) to engine (7).

(2) Lift engine generator assembly into place on skid-base and install screws (3, figure 2-3), lockwashers (5), flatwashers (4) and nuts (6) to attach engine mounts to skid-base.

(3) Attach engine speed control (3, figure 2-1) to bracket (5) and tighten nut (1).

(4) Refer to Operator and Organizational Maintenance Manual and proceed as follows:

(a) Install generator screen-guard if previously removed.

(b) Install fuel tank.

(c) Connect oil drain hose to mounting on skid-base.

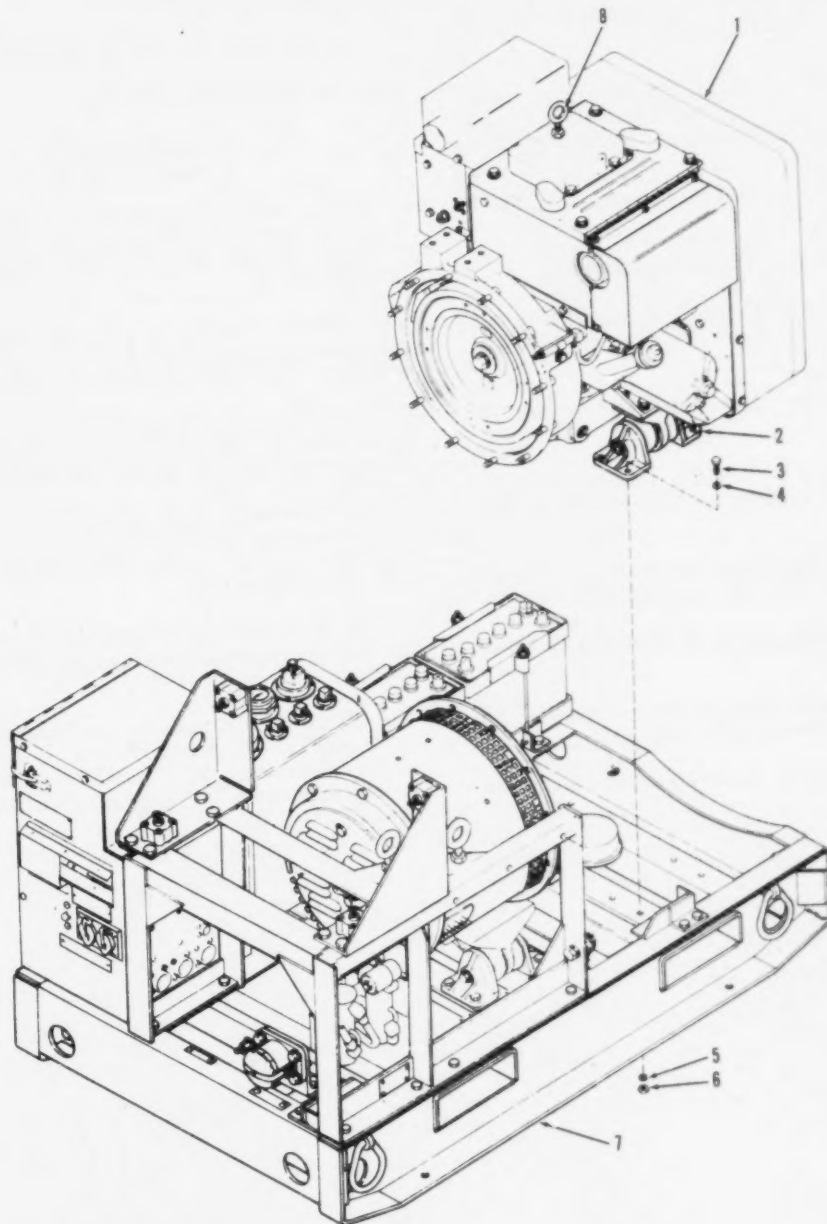
(d) Connect fuel lines to fuel filter and fuel injection pump.

(e) Install air filter assembly.

(f) Reconnect previously tagged wire harness to engine (see schematic figure 1-1).

(g) Connect cables to starter.

(h) Install batteries and reconnect.



- 1. Engine
- 2. Engine mount (2)
- 3. Screw (8)
- 4. Flatwasher (8)

- 5. Lockwasher (8)
- 6. Nut (8)
- 7. Skid-base assembly
- 8. Engine lifting bracket

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Figure 2-3. Lifting Engine

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c. Installing Engine.

(1) This installation procedure is to be followed if the engine has been removed and the generator has been left mounted on the skid-base.

(2) Lift engine into place on skid-base using engine lifting bracket (8, figure 2-3). Leave about a 6 inch space between the generator and the engine.

(3) Loosen generator mounting screws (9, figure 2-4).

(4) Mount generator to engine as follows:

(a) Install two 1/4-20 x 2 in. pilot studs into the engine flywheel (9, figure 2-2) in two holes that are 180° apart.

(b) Align fan (4), adapter plate and flywheel (9) using pilot studs.

(c) Install four screws (1), locking plate (2), pressure plate (3) attaching fan and adapter to flywheel (9).

(d) Remove pilot studs and install remaining screws (1), locking plates (2) and pressure plate (3).

(e) Bend locking plates (2) to lock all screws (1).

(f) Install twelve nuts (5) and lockwashers (6) to attach generator housing (8) to engine (7).

(5) Tighten generator mounting screws (9, figure 2-4).

(6) Attach engine supports (16, figure 2-4) to skid-base (19) with screws (12), flatwashers (13), lockwashers (14) and nuts (15).

(7) Perform step (4) of paragraph 2-9, b above.

2-10. GENERATOR ASSEMBLY.

WARNING

Engine lifting bracket is for lifting engine alone. If engine and generator assembly are lifted as one unit, use set lifting eye (18, figure 2-4).

a. Remove. Generator assembly is removed by, first removing engine and generator assembly as one unit then removing generator assembly from engine.

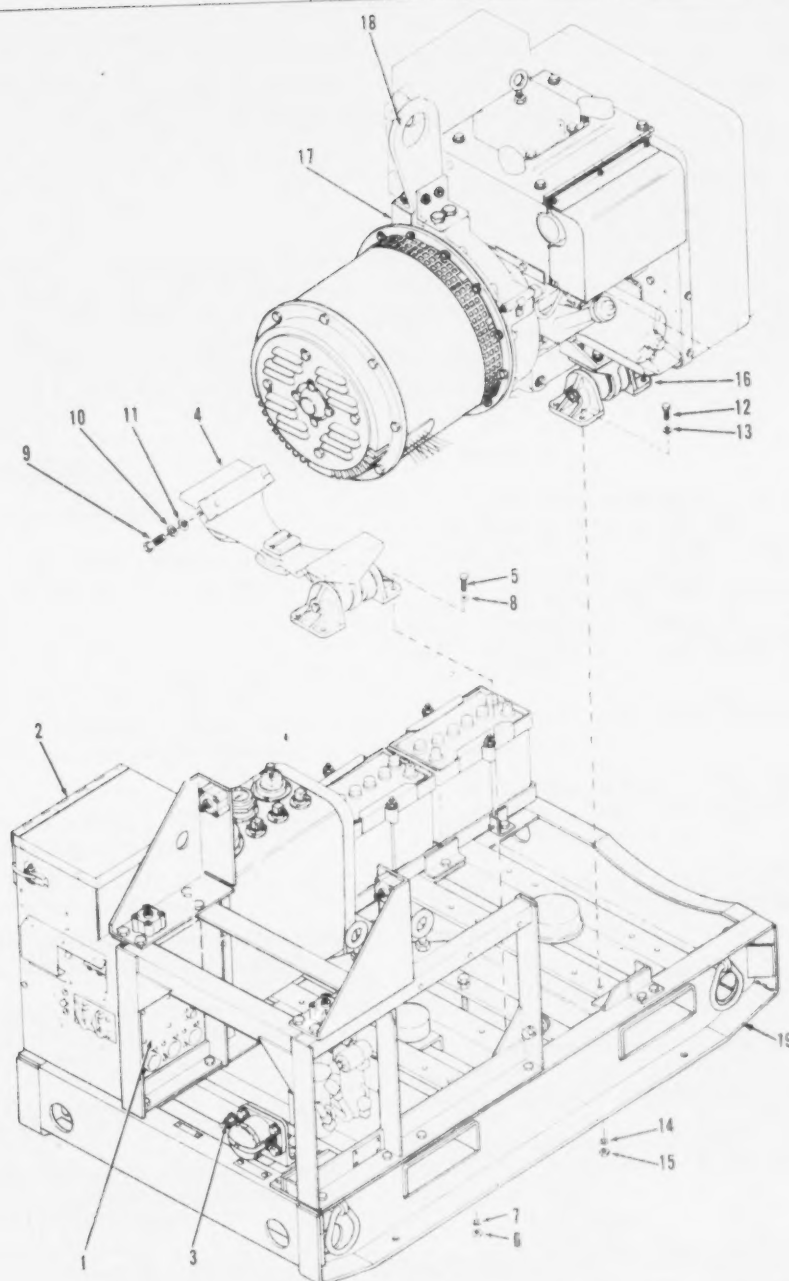
(1) Disconnect three wiring assemblies from connectors (1, figure 2-4) at ac output cubicle (2). Disconnect generator ground at ground stud (3).

(2) Disconnect four screws (5), lockwashers (7), and flatwashers (8) attaching generator support (4) to generator and lift engine and generator assembly (17) free of skid-base (19).

(3) Properly support engine and generator assembly and disconnect generator from engine assembly as given in paragraph 2-9.

b. Install. Install engine and generator assembly as described in paragraph 2-9, b. Connect three wiring assemblies to connectors (1, figure 2-4) at ac output cubicle (2). Connect generator ground at ground stud (3).

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- | | | |
|--------------------------|--------------------|------------------------|
| 1. Connector | 7. Lockwasher (8) | 14. Lockwasher (8) |
| 2. AC Output control box | 8. Flatwasher (8) | 15. Nut (8) |
| 3. Ground stud | 9. Screw (4) | 16. Engine support (2) |
| 4. Generator support | 10. Lockwasher (4) | 17. Engine-generator |
| 5. Screw (8) | 11. Flatwasher (4) | 18. Set lifting eye |
| 6. Nut (8) | 12. Screw (8) | 19. Skid-base |
| | 13. Flatwasher (8) | |

TS 6115-584-34/2-4

Figure 2-4. Lifting Engine and Generator Assembly

CHAPTER 3

MAINTENANCE OF COOLING SYSTEM

Section I. DESCRIPTION AND FUNCTION

3-1. GENERAL.

The engine has a pressure air cooling system. Fins on the engine blower draw air into the front of the engine housing and force it past the cylinders and out the right side of the engine. A separate blower on the generator rotor draws air into the rear of the gener-

ator and forces it out openings near the engine. The engine air outlet uses a shutter assembly to control engine temperature. A thermostatic element controls shutter opening which limits air flow when the engine is cold. When the engine air temperature reaches approximately 120° F, (49° C) the shutters begin to open. The shutters are completely open at 140° F (60° C) under full rated load.

Section II. MAINTENANCE

3-2. ENGINE COOLING SYSTEM.

a. Inspect on Equipment (see figure 3-1).

(1) Shutter Assembly. Inspect shutter assembly (1) for physical damage. Check for debris within assembly. Check for smooth operation of shutters when moved manually. Check for chipped paint or rusting.

(2) Bracket Assembly. Inspect that brackets (2) are securely mounted to shutters (3). Check that bracket bearings are not excessively worn. Refer to Operator and Organizational Maintenance Manual.

(3) Shutters. Inspect shutters (3) for physical damage and secure mounting to brackets (2).

(4) Air Housing Panel and Door. Inspect air housing panel and door (5) for physical damage.

(5) Grille. Inspect grille (6) for secure mounting to blower housing (7). Check for physical damage.

(6) Blower Housing. Inspect blower housing (7) for physical damage. Check that blower housing is securely mounted to engine.

b. Removal. Refer to Operator and Organizational Maintenance Manual.

c. Disassemble. Disassemble repairable components of the cooling system per Operator and Organizational Maintenance Manual.

WARNING

Solvent, Dry Cleaning P-D-680, Type II, is flammable and moderately toxic to skin, eyes and respiratory tract. Eye and skin protection required. Good general ventilation is normally adequate.

d. Repair.

(1) Shutter Assembly. Refer to Operator and Organizational Maintenance Manual to remove and replace defective components. Repair physical damage by removing the dents, welding breaks in shutter assembly box. Clean repaired area with dry cleaning solvent Federal Specification P-D-680. Paint as required with MIL-T-704, type A, semigloss, olive drab, color no. 24087.

(2) Bracket Assemblies. Replace bracket (2) or bearings if required.

(3) Shutters. Bump out dents and straighten shutters (3) if required. Clean with dry cleaning solvent and repaint if necessary.

(4) Air Housing Panel and Door. Clean air housing panel and door (5) with dry cleaning solvent and repaint if necessary.

(5) Grille. Straighten any bent wires on grille (6) or weld if required to repair.

(6) Blower Housing. Bump out dents in blower housing (7), repair cracks with welds if necessary and clean with dry cleaning solvent. Paint as required.

e. Installation. Install engine cooling system per Operator and Organizational Maintenance Manual.

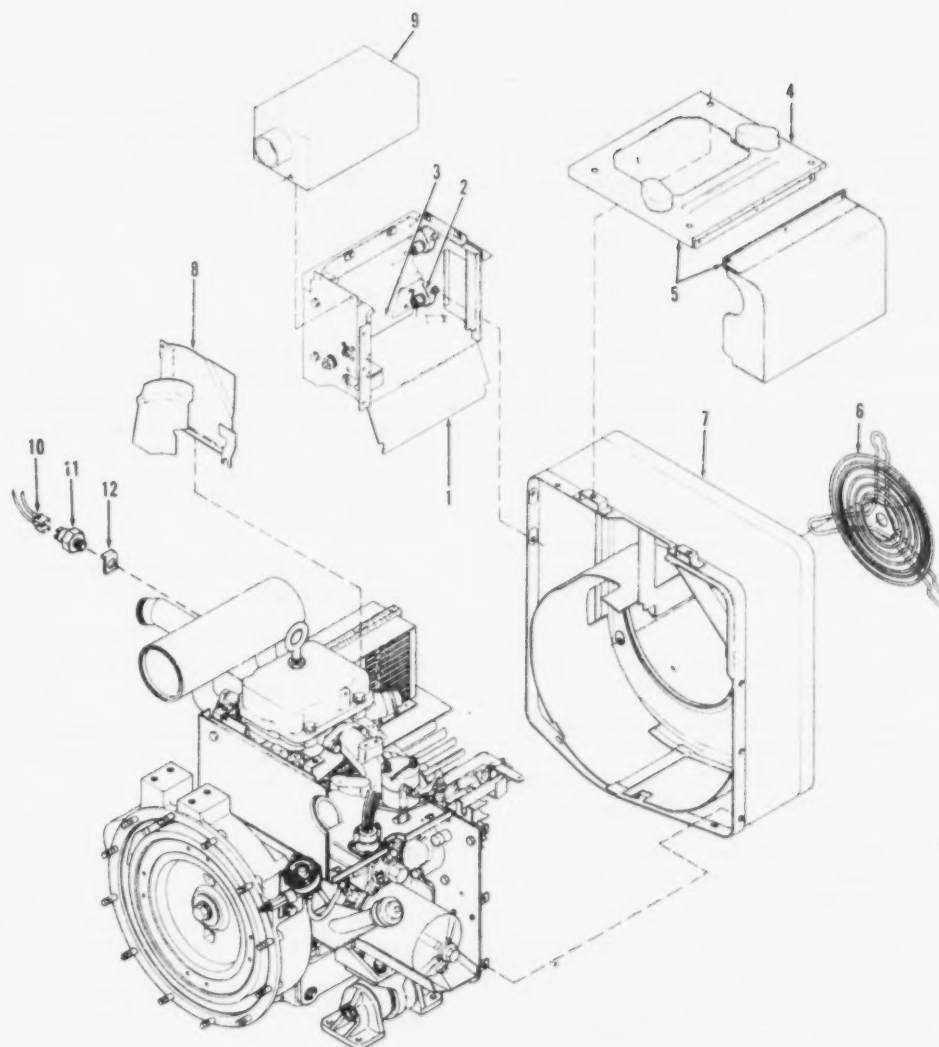
3-3. HIGH TEMPERATURE CUTOUT SWITCH.

a. Remove (see figure 3-1).

(1) Disconnect electrical leads (10).

(2) Straighten locking tab (12) and remove switch (11).

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- | | | |
|-------------------------|-------------------------------|-----------------------------|
| 1. Shutter assembly | 5. Air housing panel and door | 9. Air duct cover |
| 2. Bracket assembly (4) | 6. Grille | 10. Leads (2) |
| 3. Shutter (2) | 7. Blower housing | 11. High temperature switch |
| 4. Air housing panel | 8. Engine shroud | 12. Lock tab |

TS 6115-584-34/3-1

Figure 3-1. Engine Cooling System

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CAUTION

The high temperature cutout switch must be removed and tested semiannually (500 hours).

b. Test.

(1) Using an oil pot tester and peanut oil, heat oil to $394^{\circ} \pm 10^{\circ} \text{F}$ ($201^{\circ} \pm 5^{\circ} \text{C}$).

(2) Immerse threads and bottom surface of switch in oil. After a minimum of 1 minute, use an ohmmeter and check continuity between terminals on switch.

(3) If continuity exists, replace with a new switch.

(4) Keep threads and bottom surface of switch in oil and allow it to cool to 300°F (149°C) minimum. Repeat continuity check in (2) above.

(5) If continuity does not exist, replace with a new switch.

c. Installation.

(1) Install switch (11) on engine and lock with locking tab (12).

(2) Connect electrical leads (10) to switch terminals.

CHAPTER 4

MAINTENANCE OF FUEL SYSTEM

Section I. DESCRIPTION AND FUNCTION

4-1. GENERAL.

The engine fuel system consists of two pressure systems; the low pressure system and the high pressure system. In the low pressure system, a fuel pump may draw fuel from an external source to fill set tank or set tank may be filled manually. If an external fuel source is selected, a float valve assembly in the set tank maintains the fuel level in the tank. Two other fuel pumps (in series) draw fuel from the set tank and force the fuel through a primary strainer, two secondary filters, and a check valve assembly, to the injection pump. In the high pressure system, the fuel injection pump forces the fuel, under high

pressure, to the fuel injection nozzles. The injection nozzles provide fuel to each combustion chamber of the engine. A small quantity of unused fuel is returned from the injectors and injector pump to the fuel tank. A cam and gear on the camshaft drives the fuel injection pump. The gear drives the pump face gear, providing fuel distribution to each cylinder in the proper order. The cam operates the pump plunger, pressurizing fuel to the nozzles. A control sleeve meters fuel by controlling the length of time the plunger spill port is closed, maintaining pressure, and therefore, the amount of fuel delivered in each stroke. The pintle type injection nozzles are conventional inward opening with adjustable opening pressure. They are factory adjusted to open at 1900 to 1950 psi.

Section II. MAINTENANCE OF FUEL TANK

4-2. FUEL TANK.

a. Inspect. Inspect the fuel tank per Operator and Organizational Maintenance Manual.

b. Remove. Remove fuel tank and remove components per Operator and Organizational Maintenance Manual.

c. Test. Plug all but one opening in the fuel tank. Connect a regulated low pressure air supply to tank opening. Apply 3/4 to 1-1/4 psi to tank and submerge tank into water. Check for leaks.

d. Repair.

WARNING

Observe all safety precautions when soldering fuel tank. Avoid breathing fumes generated by lead soldering. Eye protection is required.

(1) Repair leaks in fuel tank by soldering.

(2) Clean repaired area with dry cleaning solvent Federal Specification P-D-680.

(3) Paint as required with MIL-T-704, type A, semigloss, olive drab, color no. 24087.

e. Install.

(1) Install the fuel tank and components per Operator and Organizational Maintenance Manual.

(2) Fill tank with fuel oil.

CHAPTER 5

MAINTENANCE OF STARTING SYSTEM

Section I. DESCRIPTION AND FUNCTION

5-1. GENERAL.

The engine is cranked by a 24 volt starting motor (see figure 5-1). When the starting motor solenoid is energized, the solenoid core pulls in, shifting the pinion into engagement with the engine flywheel ring gear. The starting motor is protected from over-

speeding by engine by an overrunning clutch. At the same time, contacts in the solenoid close to provide a circuit for the starting motor. Two 12 volt batteries in series are used. The starting switch for this starting circuit is located in the control cubicle. Refer to the Operator and Organizational Maintenance Manual for starting and operating the set. A blower wheel alternator is utilized to recharge the batteries.

Section II. MAINTENANCE

5-2. STARTER ASSEMBLY.

a. Test, on Equipment. Refer to the Operator and Organizational Maintenance Manual.

b. Removal. Refer to Operator and Organizational Maintenance Manual.

c. Disassembly (see figure 5-1).

(1) Remove nut (1) and lockwasher (2) from solenoid (9). Tag and remove lead (3). Remove nut and lockwasher from solenoid and disconnect connector and grommet (4).

(2) Remove cotter pin (5) and pin (6) from yoke (26). Remove screws (7), lockwashers (8) and remove solenoid switch (9).

(3) Remove through bolts (10), lockwasher (11) and remove back plate assembly (12) and thrust washer (21). Remove nuts and washers from brush terminal (15). Raise brush spring (14) and lift brushes (15) from brush holder. Remove screws (16), lockwashers (17) and remove brush holder (18). Raise springs (14) and lift other brushes from brush holder. Remove springs (14) from brush holder.

(4) Remove retainer (23), boot (24), pin (25) and separate pinion housing (22) and frame assembly (19). Do not lose thrust washer (21). Remove other set of brushes (20) by cutting leads one inch on each side of welded connection (see figure 5-9).

(5) Remove yoke (26) and remove armature (27) and drive assembly (29). Remove lock ring and stop (28) by pressing stop toward armature until lock ring becomes accessible. Remove lock ring (28) and drive

assembly (29) from armature (27). Do not disassemble drive assembly.

(6) Remove bearing (30) by pressing from pinion housing.

d. Cleaning Inspection.

(1) Cleaning. Clean dust off parts with compressed air or soft brush. Remove grease and oil with dry cleaning solvent.

CAUTION

Do not saturate armature or field coils with solvent as wire insulation may be damaged. Do not dip drive assembly in solvent as it is packed in grease and cannot be repacked.

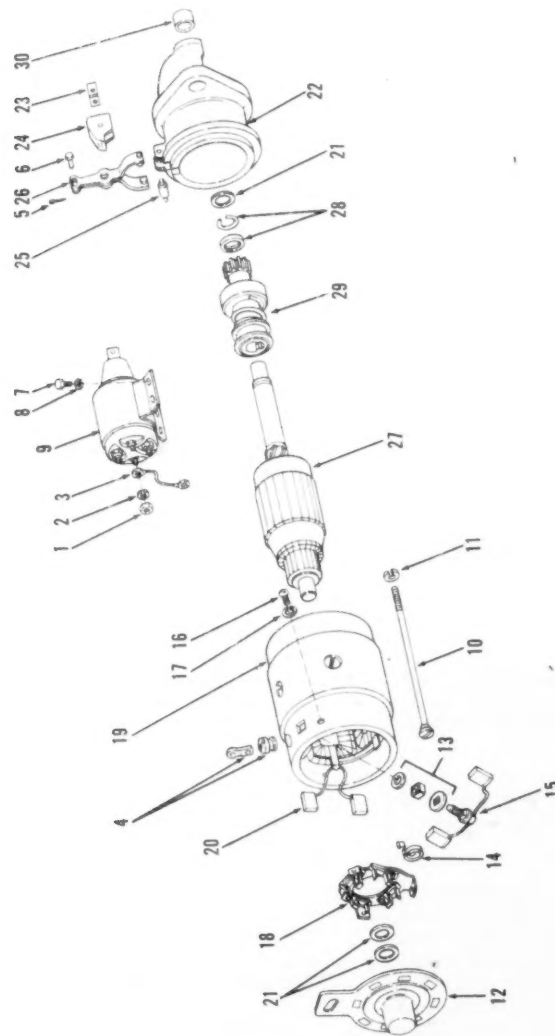
Remove discoloration or oxidation from commutator with fine sand paper grade 00. Clean off sand with compressed air. Use only sandpaper.

(2) Bearings. Inspect bearings (30, figure 5-1) for wear. Replace if excessively worn. Inspect bearing in back plate assembly (12). If excessively worn replace back plate assembly.

(3) Drive Assembly. Refer to Operator and Organizational Maintenance Manual.

(4) Brushes. Refer to Operator and Organizational Maintenance Manual.

(5) Solenoid Switch. Refer to Operator and Organizational Maintenance Manual.



1. Nut
2. Lockwasher
3. Lead
4. Connector and grommet
5. Cotter pin
6. Pin
7. Screw (4)
8. Lockwasher (4)

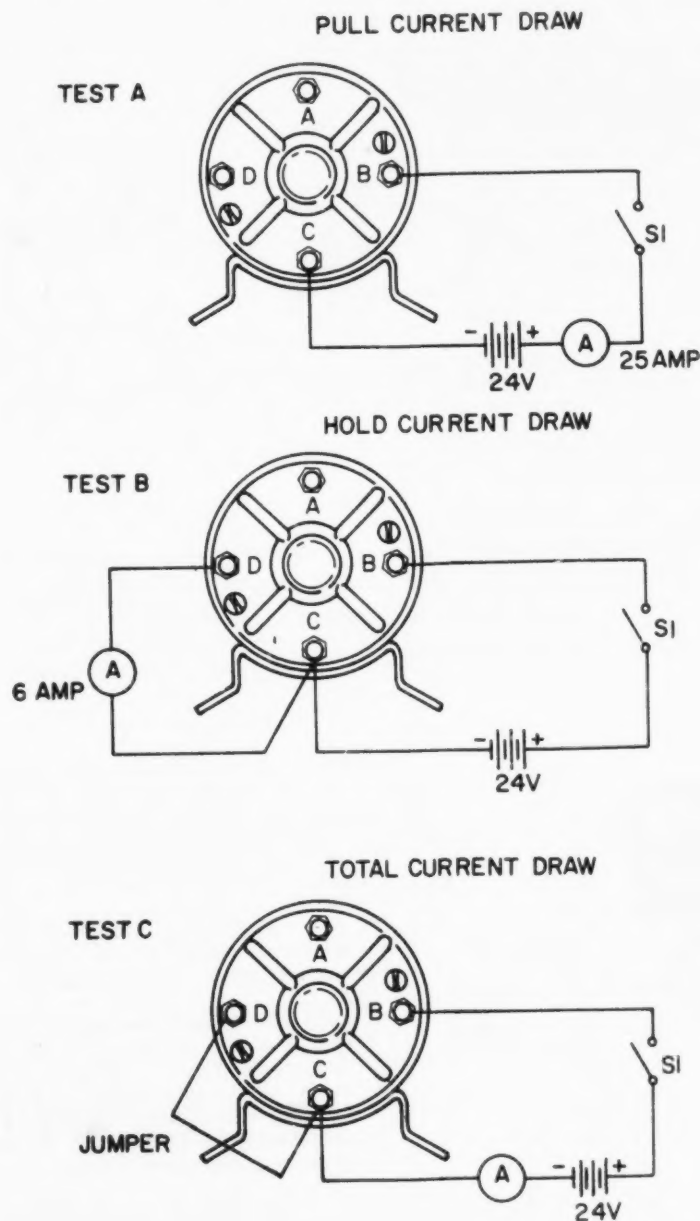
9. Solenoid switch
10. Thru bolt (2)
11. Lockwasher (2)
12. Back plate assembly
13. Brush washer
14. Brush spring (4)
15. Brush assembly

16. Screw (3)
17. Lockwasher (3)
18. Brush holder
19. Frame assembly
20. Brush assembly
21. Thrust washer (3)
22. Pinion housing

23. Retainer
24. Boot
25. Pin
26. Yoke
27. Armature
28. Lock ring and stop
29. Drive assembly
30. Bearing

TS 6115-584-34/5-1

Figure 5-1. Electric Starter Assembly



TS 6115-584-34/5-2

Figure 5-2. Testing Solenoid Switch

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(6) Armature. Inspect armature (27, figure 5-1) for wear. Inspect commutator for wear. Turn commutator surfaces on a lathe to remove grooves and out-of-round. Replace if excessively worn.

(7) Yoke. Inspect yoke (26) for damage or wear.

(8) Frame Assembly. Inspect frame assembly (19) for damage. Check wires of field coil for burning or worn insulation. Check pole shoes for tightness. Check field coils for signs of armature contact which indicates bad bearings. Repair or replace if defective.

a. Test Bench.

(1) Testing Starter. Refer to Operator and Organizational Maintenance Manual.

(2) Testing Armature.

(a) Testing Armature for Grounds. Touch armature shaft and the end of each commutator bar with a pair of ohmmeter leads. There should be no continuity. If continuity is indicated between any commutator bar and shaft, it indicates a grounded armature. Replace a grounded armature. See figure 5-3.

(b) Testing Armature for Shorted Coils. A growler is necessary to test for shorted coils. With the armature in the growler turn the growler on and

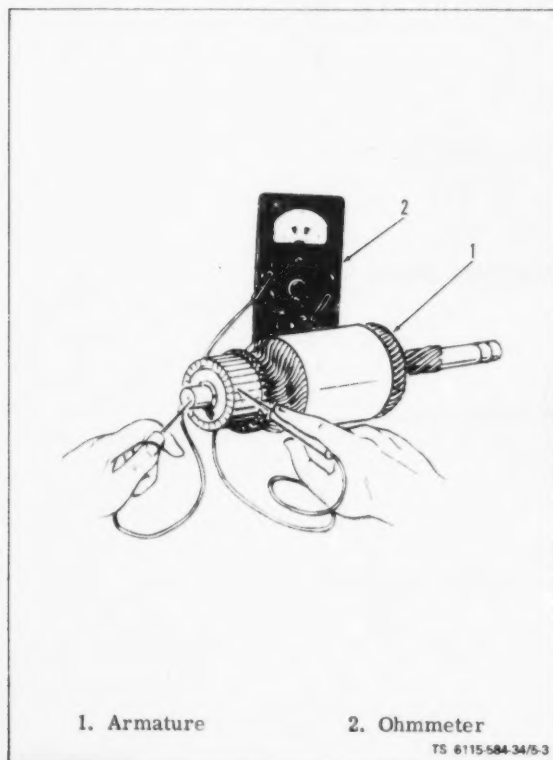


Figure 5-3. Testing Armature for Grounds

5-4

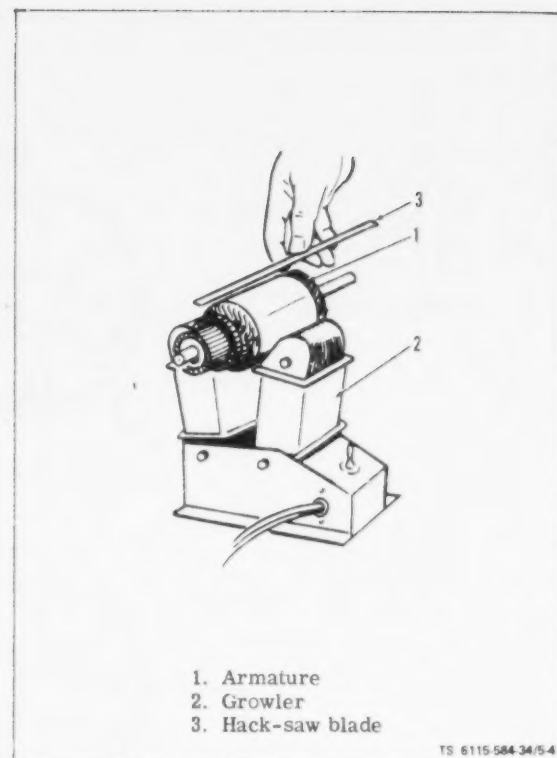


Figure 5-4. Testing Armature for Shorted Coils

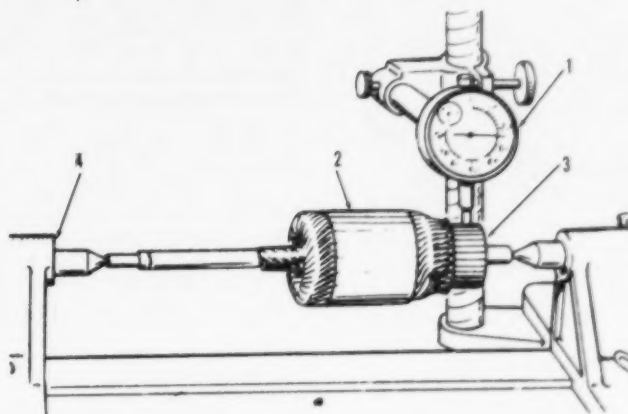
run a steel strip over the armature surfaces. If a coil is shorted, the steel strip will become magnetized and vibrate. Rotate the armature slightly and repeat the test. Do this for one complete revolution of the armature. See figure 5-4. If the armature has a short or ground, replace it.

(c) Testing Armature for Open Coils. Test coils for continuity with ohmmeter. High resistance reading indicates open coil.

(d) Testing Commutator Runout. Place armature in a test bench and check runout with a dial indicator. See figure 5-5. When commutator runout exceeds .004", commutator should be refaced. After refacing commutator, check that it meets minimum specifications. Check and, if necessary, undercut mica as given under repair.

(e) Testing Armature Shaft Runout. Place armature in a test bench and check shaft runout with a dial indicator. See figure 5-6. If the shaft is bent or worn armature must be replaced. Should not exceed 0.006 inch.

(3) Testing Field Coils. See Operator and Organizational Maintenance Manual.



1. Dial indicator

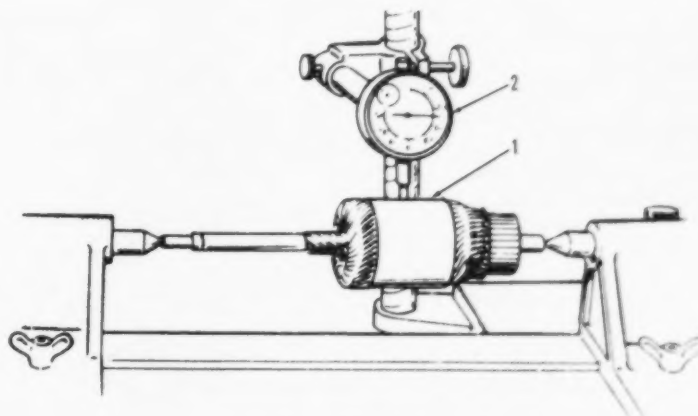
2. Armature

3. Commutator

4. Lathe

TS 6115-584 24/5/6

Figure 5-5. Checking Commutator Runout



1. Armature

2. Dial indicator

TS 6115-584 24/5/6

Figure 5-6. Testing Armature Shaft Runout

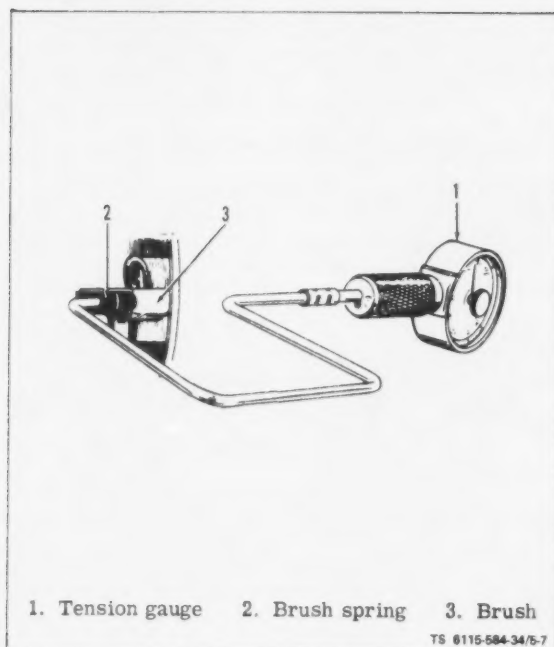


Figure 5-7. Testing Brush Spring Tension

(4) Testing Brushes. See Operator and Organizational Maintenance Manual.

(5) Testing Brush Springs. Measure brush spring tension with a tension meter. See figure 5-7. Push the brush and take a reading just as the brush projects a little from the brush holder. On a new brush the spring tension should be 32 to 40 ounces. If brush spring tension is below 20 ounces, replace.

(6) Testing Solenoid Switch (see figure 5-2).

(a) Check to be sure plunger moves freely in coil. Measure the pull-in coil current draw by using Test A. Current should not exceed 16 amps.

(b) Measure the hold-in coil draw using Test B. Current should not exceed 6 amps.

(c) Total hold and pull current draw using Test C is 22 amps. Total current draw should not exceed 25 amps. Replace a bad solenoid.

f. Repair.

(1) Repairing Starter. Repair starter by replacing defective components. Repair procedures for individual components are given below.

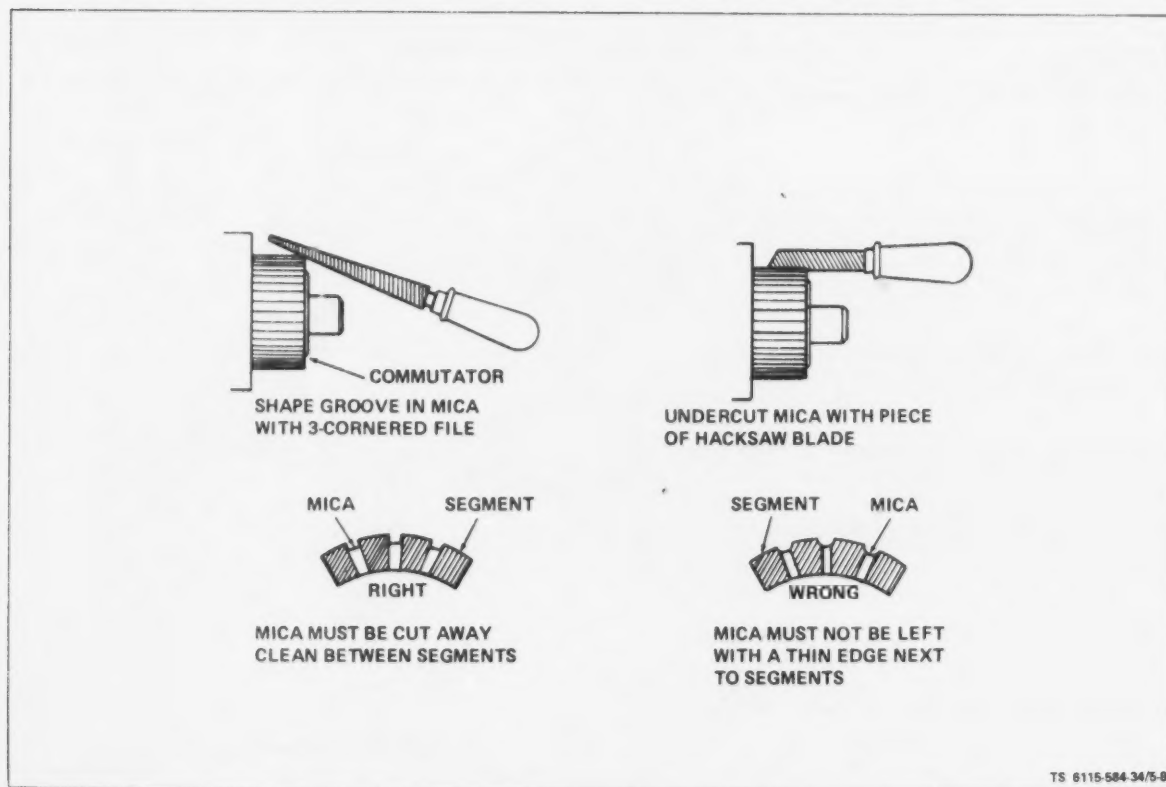


Figure 5-8. Undercutting Mica

(2) Repairing Armature. If wear or runout on the commutator is not excessive, it may be resurfaced as follows.

(a) Resurfacing Commutator. Turn commutator down in a lathe. Commutator must not be turned down to less than 1-1/16 inches.

(b) Undercutting Mica. After resurfacing commutator, undercut mica to a depth 0.025 to 0.032 inch below surface of commutator using a power-driven undercutting tool. If a power-driven tool is not available, mica may be undercut by hand. See figure 5-7.

NOTE

Use care in undercutting. Do not widen commutator slots by removing metal from bars, and do not leave a thin edge of mica next to bars. Figure 5-8 illustrates examples of good and bad undercutting. After mica has been undercut, remove all copper and mica particles with compressed air. Polish commutator in a lathe with number 00 to 000 sandpaper while the armature is rotating.

g. Reassembly (see figure 5-1).

(1) Before assembly, soak bronze bearing (30) in SAE 10 oil for 15 minutes.

(2) Press bearing (30) into pinion housing (22).

(3) Slide drive assembly (29) onto shaft of armature (27). Install stop and lock ring (28) on the end of the armature shaft (27).

(4) Install thrust washer (21) on the end of the armature shaft (27). Slip yoke (26) onto drive assembly (29) and install both in pinion housing (22). Install pin (25) in pinion housing (22) to hold yoke (26) in place.

(5) If brushes (20) are excessively worn, cut brush leads 1 inch from the welded connection (see figure 5-9). Install new brushes as follows:

(a) Using rosin core solder and a soldering iron, or heavy duty soldering gun, tin the remaining sections of the original brush lead.

(b) Position the new brush lead next to the tinned sections of the original brush lead. Install and crimp the brass strip connectors (included) around both leads to hold the new brushes in place. See figure 5-9.

(c) Solder the new brushes in place. Position the brush leads so they do not contact the frame or interfere with thru bolt installation.

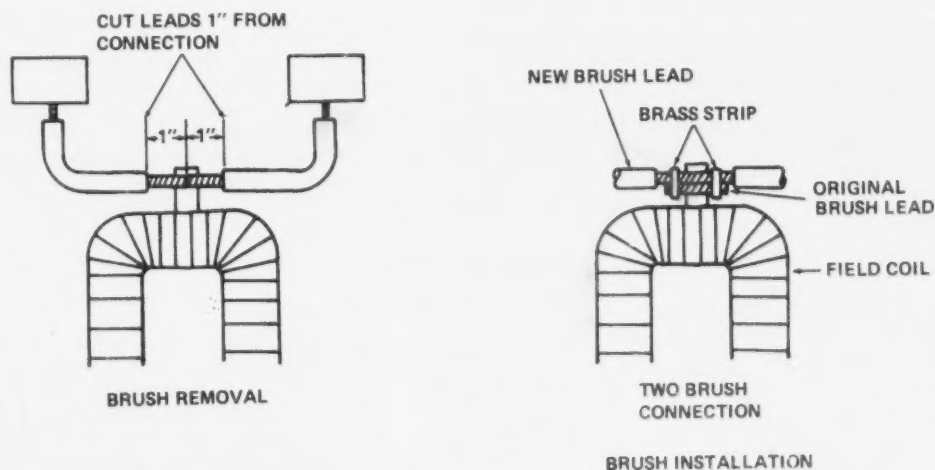


Figure 5-9. Brush Replacement

(6) Install brush assembly (15, figure 5-1) and brush washers (13) in frame assembly (19) and install previously removed lockwasher and nut on stud of brush assembly (15).

(7) Install brushes (15 and 20) in brush holder (18). Attach brush holder (18) to frame assembly (19) with screws (16) and lockwashers (17).

(8) Assemble armature (27), drive (29) and pinion housing (22) with frame assembly (19).

(9) Install brush springs (14).

(10) Install thrust washers (21) on the end of the armature shaft (27) and install back plate assembly (12) on frame assembly (19) with thru bolts (10) and lockwashers (11).

(11) Install solenoid switch (9) on frame assembly (19) with screws (7) and lockwashers (8) so that bottom terminal of solenoid (9) goes through connector (4). Attach terminal to connector with hardware on the solenoid switch (9). Connect plunger of solenoid (9) and yoke (26) with pin (6). Retain pin (6) with cotter pin (5). Install boot (24) and retainer (23) over yoke (26).

(12) Connect tagged lead (3) between solenoid switch (9) and brush assembly (15). Install nut (1) and lockwasher (2). Remove tags.

h. Test After Repair/Overhaul.

(1) After the motor is assembled, check the armature end play by inserting thickness gauge between thrust washer and pinion housing. It should be between 0.005 inch and 0.035 inch. Adjust end play by adding or removing washers (21, figure 5-1) on the commutator end of the armature.

(2) Before installing, check the pinion clearance. Proper clearance is important to insure starter

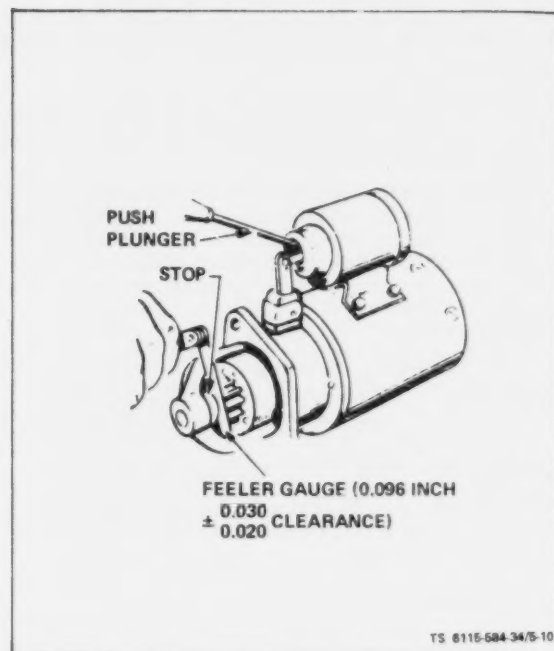


Figure 5-10. Checking Pinion Clearance

engagement. Press on solenoid core to shift the pinion into full mesh and measure the clearance between pinion and pinion stop (figure 5-10). This should be 0.096 ± 0.030 inch. Adjust the link screw on the end of the solenoid plunger for proper clearance.

i. Installation. Refer to Operator and Organizational Maintenance Manual.

CHAPTER 6

MAINTENANCE OF CONTROL SYSTEM

Section I. DESCRIPTION AND FUNCTION

6-1. DC CONTROL SYSTEM.

Refer to the Operator and Organizational Maintenance Manual for the description and function of the dc control system.

6-2. AC INSTRUMENTATION SYSTEM.

Refer to the Operator and Organizational Maintenance Manual for description and function of the ac instrumentation system.

6-3. VOLTAGE REGULATOR.

Excitation current is controlled through the static type automatic voltage regulator. The voltage regulator continuously compares the output voltage of the synchronous generator with a stable reference voltage. The difference between the two voltages constitutes an error signal which indicates an output voltage that is higher or lower than the generator set point. This error signal is amplified and used to control the direct current output of the voltage regulator which is applied to the control windings of the current-voltage transformers.

Section II. MAINTENANCE

6-4. CONTROL CUBICLE.

a. Wiring Harness.

(1) Remove. Disconnect wires of wiring harness from all components. Remove clamp attaching harness to control panel and remove harness.

(2) Repair. Table 6-1 lists the wire number, gauge, color, length and terminal lugs for each wire in the harness. Repair consists of replacing wires as required.

(3) Installation. Install harness by connecting wires to components per figure 6-1. Attach harness to control panel with clamp.

b. Meters (on equipment test).

(1) Frequency Meter (M3) (16, figure 6-3). Connect a frequency meter of known accuracy to single phase output terminals of load terminal board. Make certain reconnection switch is in proper position for single phase output. Operate Generator Set and check readings of panel meter (M3) against test frequency meter. If panel meter does not give the same reading as the test meter, test transducer as given in (2) below.

(2) Frequency Transducer (A3) (56, figure 6-3). Test transducer using the same procedure as for testing frequency meter. If transducer does not give proper meter reading, replace the transducer and/or the meter.

(3) Percent Current Meter (M4) (17, figure 6-3). Connect an ac test ammeter in series with the $\frac{1}{2}$ rated current meter. Operate Generator Set with a single phase load. Continue adding load to set until meter reads 0.75 amps. Meter (M4) should read $100\% \pm 2\%$. Replace meter if necessary.

(4) AC Voltmeter (M5) (18, figure 6-3). Attach test ac voltmeter in parallel (across terminals) with panel ac voltmeter (M5). Operate Generator Set and compare readings of the two meters. Panel voltmeter must be accurate to $\pm 2.5\%$, except between 115 and 125 volts, accuracy must be ± 3 volts and between 200 and 250 volts, accuracy must be ± 5 volts. If panel meter does not meet these requirements, replace meter.

c. Meters (remove).

(1) Frequency Meter (M3) (16, figure 6-3). Tag and disconnect two leads from meter. Remove three screws, lockwashers, and nuts attaching meter to panel and remove meter.

(2) Frequency Transducer (A3) (56, figure 6-3). Tag and disconnect four leads to frequency transducer. Remove four screws (54) and nuts (55) attaching transducer to back of control cubicle and remove transducer.

(3) Percent Current Meter (M4) (17, figure 6-3). Tag and disconnect two leads from meter. Remove three screws, lockwashers, and nuts attaching meter to control panel and remove meter.

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WIRE NO.	FROM	TO	WIRE NO.	FROM	TO	WIRE NO.	FROM	TO	WIRE NO.	FROM	TO
D24A16	M5-2	S8-11	P55C10	J1-C	TB4-14	P62D16	J2-A	TB5-6	X17F16	S8-28	TB5-14
D25A16	M5-1	S8-21	P55D16	J2-W	TB4-13	P64A16	A1-4	TB5-8	X22C16	J2-b	S8-18
D26A16	M4-1	S8-41				P64B16	M2-1	TB5-8	X23C16	J2-a	S8-12
D26B16	J2-F	S8-31	P55H16	DS2-1	TB4-12	P64C16	J2'D	TB5-8	X29C16	J2-h	S8-52
D27A16	M4-2	S8-51	P55J16	DS1-1	TB4-13	P64E16	M1-1	TB5-8	X31D16	J2-k	S8-54
D74A16	M3-2	A3-	P55L16	J1-D	TB4-12	P66C16	J2-G	TB5-9	X34C16	J2-e	TB5-4
D75A16	M3-1	A3+	P55N16	M2-2	TB4-12	P66D16	S1-28	TB5-9	X34D16	S8-33	TB5-4
H52A12	K2-A2	TB4-7	P55P16	A1-2	TB4-14	P66F16	A1-1	TB5-9	X34F16	S8-57	TB5-4
H52B12	J2-P	TB4-7	P55R16	J1-F	TB4-11	P66F16	J2-1	TB5-9	X35C16	J2-g	S8-53
H52H12	J2-R	TB4-8	P55U16	K2-X2	TB4-13	P67E16	J2-Z	TB4-4	X39C16	J2-X	A2-17
K51A12	J2-S	K3-A2	P57A16	S1-27	TB4-10	P67F16	A2-12	TB4-4	X40C16	J2-Y	A2-14
L56A16	S2-2	TB4-9	P57B16	A1-5	TB4-10	P67G16	T1-X2	TB4-4	X41A16	R1-2	A2-8
L56B16	DS2-2	TB4-9	P57C16	A1-8	TB4-10	X9G16	J2-L	TB5-12	X42A16	R1-1	A2-13
L56C16	DS1-2	TB4-9	P58A16	K3-X1	A1-6	X9H16	A3-1	TB5-12	X43A16	T2-X2	A2-10
P50B10	J1-A	TB4-5	P59C16	J2-M	TB4-3	X9J16	T2-H1	TB5-12	X44A16	T2-X1	A2-11
P50C12	K2-A1	TB4-5	P60A16	A1-7	TB5-5	X9K16	T1-H1	TB5-12	X45A16	T1-X1	A2-15
P50D12	K3-A1	TB4-6	P60B16	A2-18	TB5-5	X12G16	J2-H	TB5-13	X49A16	T1-X3	A2-16
P50E16	CB2-2	TB4-6	P60C16	J2-N	TB5-5	X12H16	A3-2	TB5-13	P59D16	K3-X2	TB4-3
P50F16	J2-C	TB4-6	P61A16	S1-14	TB5-7	X12J16	T2-H2	TB5-13	P59E16	J2-J	TB4-3
P53A16	CB2-1	TB5-11	P61B16	A1-3	TE5-7	X12K16	T1-H2	TB5-13			
P53B16	S1-11	TB5-10	P61C16	J2-F	TB5-7	X14D16	J2-c	S8-15			
P53C16	S1-25	TB5-11	P61E16	J2-E	TB5-7	X15D16	J2-d	S8-24			
P53D16	S2-1	TB5-11	P62A16	S1-17	TB5-6	X17D16	J2-k	TB5-14			
P54A16	S1-15	K2-X1	P62B16	J2-B	TB5-6	X17E16	S8-26	TB5-14			

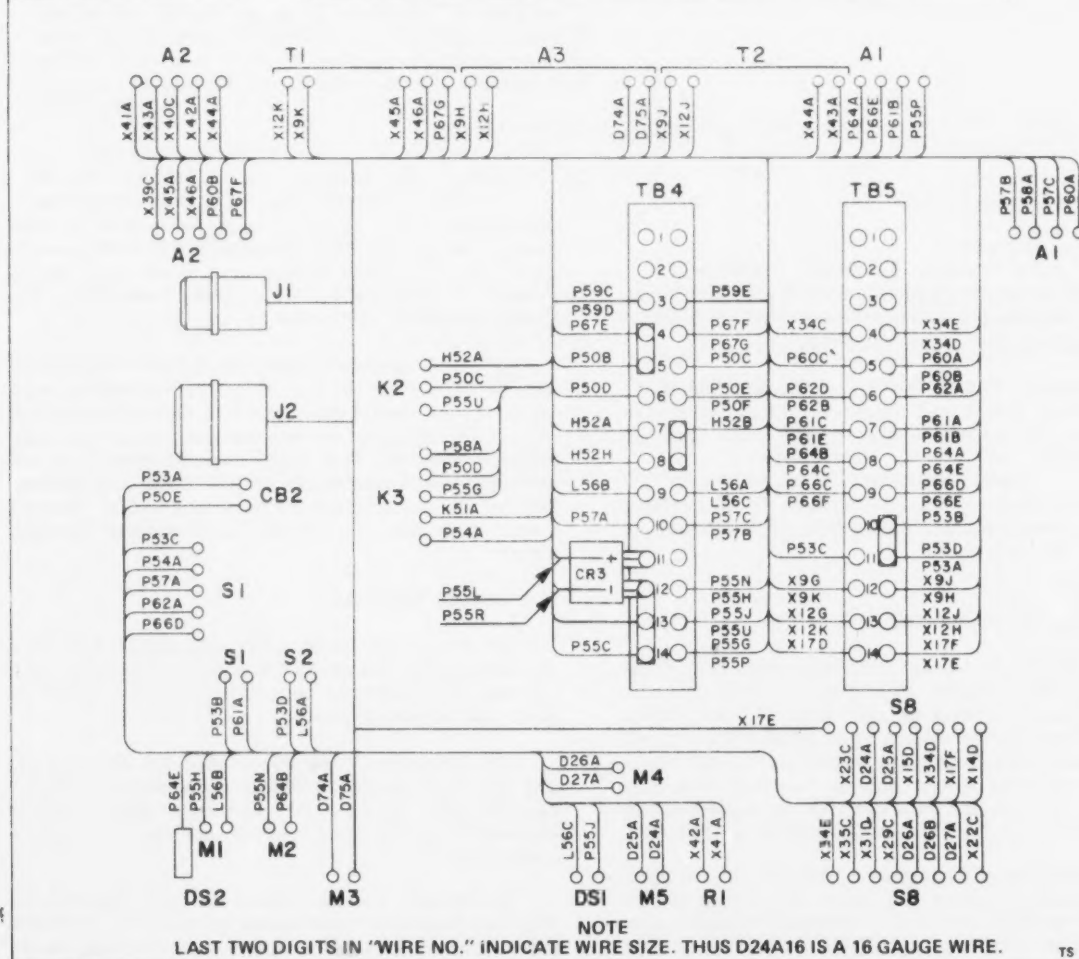


Figure 6-1. Control Cubicle Wiring Harness

Table 6-1. Control Cubicle Wiring Harness

NOTE

All wires are copper, 600V, per MIL-W-5086/2.

Wire No.	Gauge	Marking Color	Length in Inches	Terminal Find No. Terminal Lugs
D24A16	16	black	13	MS25036-154, MS25036-107
D25A16	16	black	13	MS25036-154, MS25036-107
D26A16	16	black	10	MS25036-154, MS25036-107
D26B16	16	black	24	MS25036-107
D27A16	16	black	10.5	MS25036-154, MS25036-107
D74A16	16	black	31.5	MS25036-154, MS25036-107
D75A16	16	black	32	MS25036-154, MS25036-107
H52A12	12	red	9.5	MS25036-112, 332-1819*
H52B12	12	red	18	332-1819*
H52H12	12	red	18	332-1819*
K51A12	12	red	21	MS25036-112
L56A16	16	red	39	MS25036-107, MS25036-107
L56B16	16	red	38.5	MS25036-107, MS25036-107
L56C16	16	red	42	MS25036-107, MS25036-107
P50B10	10	red	11.5	332-1819*
P50C12	12	red	20	MS25036-112, 332-1819*
P50D12	12	red	9	MS25036-112, 332-1819*
P50E16	16	red	41	MS25036-153, MS25036-107
P50F16	16	red	15.5	MS25036-107
P53A16	16	red	46.5	MS25036-153, MS25036-107
P53B16	16	red	37	MS25036-107, MS25036-107
P53C16	16	red	46	MS25036-107, MS25036-107
P53D16	16	red	44	MS25036-107, MS25036-107
P54A16	16	red	42	MS25036-107, MS25036-107
P55C10	10	red	15	332-1819*
P55D16	16	red	18	MS25036-107
P55G16	16	red	19	MS25036-107, MS25036-107
P55H16	16	red	42	MS25036-107, MS25036-107
P55J16	16	red	44	MS25036-107, MS25036-107
P55L16	16	red	16.5	MS25036-107
P55N16	16	red	40	MS25036-107, MS25036-107
P55P16	16	red	13	MS25036-107, MS25036-107
P55R16	16	red	16.5	MS25036-107
P55U16	16	red	24	MS25036-107, MS25036-107
P57A16	16	red	38.5	MS25036-107, MS25036-107
P57B16	16	red	17	MS25036-107, MS25036-107
P57C16	16	red	17	MS25036-107, MS25036-107
P58A16	16	red	27	MS25036-107
P59C16	16	red	22	MS25036-107
P60A16	16	red	11.5	MS25036-107, MS25036-107
P60B16	16	red	36	MS25036-107, MS25036-107
P60C16	16	red	19.5	MS25036-107
P61A16	16	red	39.5	MS25036-107, MS25036-107
P61B16	16	red	10	MS25036-107, MS25036-107

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Table 6-1. Control Cubicle Wiring Harness (Cont)

Wire No.	Gauge	Marking Color	Length in Inches	Terminal Find No. Terminal Lugs
P61C16	16	red	19.5	MS25036-107
P61E16	16	red	19.5	MS25036-107
P62A16	16	red	42	MS25036-107, MS25036-107
P62B16	16	red	19.5	MS25036-107
P62D16	16	red	19.5	MS25036-107
P64A16	16	red	9.5	MS25036-107, MS25036-107
P64B16	16	red	41	MS25036-107, MS25036-107
P64C16	16	red	21.5	MS25036-107
P64E16	16	red	21	MS25036-107, 323-0705*
P66C16	16	red	43	MS25036-107
P66D16	16	red	12	MS25036-107, MS25036-107
P66E16	16	red	21	MS25036-107, MS25036-107
P66F16	16	red	15	MS25036-107
P67E16	16	red	30.5	MS25036-107
P67F16	16	red	12	MS25036-107, MS25036-107
P67G16	16	red	42	MS25036-153, MS25036-107
X9G16	16	black	23	MS25036-107
X9H16	16	black	19	MS25036-107, MS25036-107
X9J16	16	black	16	MS25036-153, MS25036-107
X9K16	16	black	21	MS25036-153, MS25036-107
X12G16	16	black	23	MS25036-107
X12H16	16	black	19	MS25036-107, MS25036-107
X12J16	16	black	16	MS25036-153, MS25036-107
X12K16	16	black	22	MS25036-153, MS25036-107
X14D16	16	black	24	MS25036-107
X15D16	16	black	22.5	MS25036-107
X17D16	16	black	23	MS25036-107
X17E16	16	black	42	MS25036-107, MS25036-107
X17F16	16	black	45	MS25036-107, MS25036-107
X22C16	16	black	23	MS25036-107
X23C16	16	black	22	MS25036-107
X29C16	16	black	25	MS25036-107
X31D16	16	black	25.5	MS25036-107
X34C16	16	black	19	MS25036-107
X34D16	16	black	40.5	MS25036-107, MS25036-107
X34E16	16	black	44.5	MS25036-107, MS25036-107
X35C16	16	black	25	MS25036-107
X39C16	16	black	27	MS25036-107
X40C16	16	black	28.5	MS25036-107
X41A16	16	black	54.5	MS25036-153, MS25036-107
X42A16	16	black	54	MS25036-153, MS25036-107
X43A16	16	black	37	MS25036-153, MS25036-107
X44A16	16	black	35	MS25036-153, MS25036-107
X45A16	16	black	25	MS25036-153, MS25036-107
X46A16	16	black	26.5	MS25036-153, MS25036-107

* Onan Division of Onan Corporation (44940)

Table 6-2. 5KW Generator Set Wiring Harness

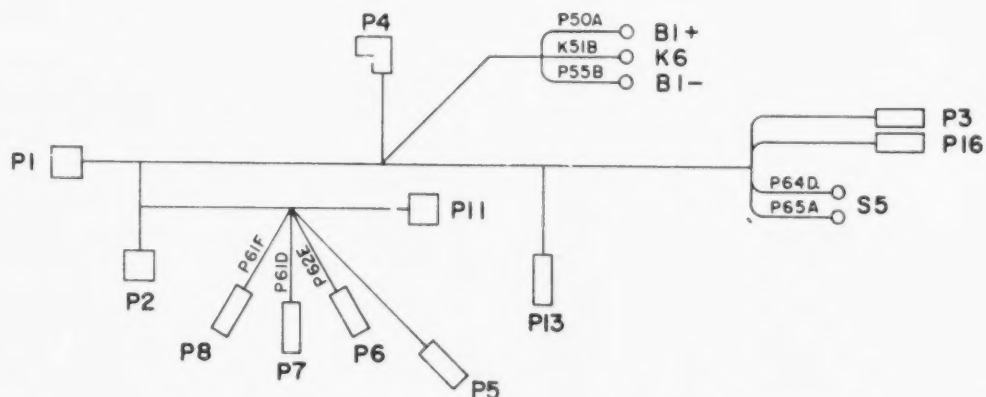
NOTE

All wires are copper, 600V, per MIL-W-5086/2.

Wire No.	Gauge	Marking Color	Length in Inches	Terminal Lugs
D26C16	16	black	31	-
H52C12	12	red	53	-
H52J12	12	red	53	-
K51B12	12	red	35	MS25036-112
P50A10	10	red	39	MS25036-113
P50G16	16	red	53	-
P55B10	10	red	36	MS25036-113
P59F16	16	red	31	-
P55M16	16	red	35	-
P55S16	16	red	55	-
P55E16	16	red	47	-
P59B16	16	red	47	-
P60D16	16	red	31	-
P61D16	16	red	20	-
P61F16	16	red	20.5	-
P62C16	16	red	26	-
P62E16	16	red	20	-
P63A16	16	red	49	-
P64D16	16	red	49	MS25036-153
P65A16	16	red	38	MS25036-153
P66B16	16	red	26.5	-
P66G16	16	red	53	-
P67D16	16	red	31	-
X9F16	16	black	31	-
X12F16	16	black	31	-
X14C16	16	black	31	-
X15C16	16	black	31	-
X17C16	16	black	31	-
X22B16	16	black	31	-
X23B16	16	black	31	-
X29B16	16	black	31	-
X31C16	16	black	31	-
X34B16	16	black	31	-
X35B16	16	black	31	-
X39B16	16	black	31	-
X40B16	16	black	31	-

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WIRE NO.	FROM	TO	WIRE NO.	FROM	TO
D26C16	P2-f	P11-H	P66B16	P2-G	P13-A
H52C12	P2-P	P3-F	P66G16	P2-1	P3-A
G52J12	P2-R	P3-B	P67D16	P2-Z	P11-J
K51B12	P2-S	K6-1	X9F16	P2-L	P11-B
P50A10	P1-A	B1+(K6)	X12F16	P2-H	P11-N
P50G16	P2-C	P3-E	X14C16	P2-c	P11-R
P55B10	P1-C	B1-(K6)	X15C16	P2-d	P11-U
P55E16	P2-J	P11-A	X17C16	P2-K	P11-V
P55M16	P1-D	P5-A	X22B16	P2-b	P11-E
P55S16	P1-F	P3-C	X23B16	P2-a	P11-S
P58B16	P2-M	P16-A	X29B16	P2-h	P11-C
P59B16	P2-W	P16-B	X31C16	P2-k	P11-G
P60D16	P2-N	P11-K	X34B16	P2-e	P11-P
P61D16	P2-F	P7	X35B16	P2-g	P11-D
P61F16	P2-E	P8	X39B16	P2-X	P11-F
P62C16	P2-B	P4-A	X40B16	P2-Y	P11-T
P62E16	P2-A	P6			
P63A16	P5-B	P4-B			
P64D16	P2-D	S5-1			
P65A16	P13-B	S5-2			



NOTE

Last two digits in "wire no." indicate wire size. Thus D26C16 is a 16 gauge wire. The letter P indicates plug. The last digit indicates pin number. Thus wire D26C16 goes from plug 2, pin f to plug 11, pin H.

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Figure 6-2. Generator Set Wiring Harness

Table 6-3. AC Output Control Box Wiring Harness

NOTE

All wires are copper, 600V, per MIL-W-5086/2.

Wire No.	Gauge	Marking Color	Length in Inches	Terminal Lugs
D26D16	16	black	21	MS25036-107
D26E16	16	black	17	MS25036-107, MS25036-108
D26F16	16	black	17	MS25036-107, MS25036-108
D26G16	16	black	32	MS25036-107, MS25036-153
D26H16	16	black	15	MS25036-107, MS25036-108
D26J16	16	black	3.5	MS25036-107
D26K16	16	black	34	MS25036-107, MS25036-153
P55F16	16	red	24	MS25036-107
P60E16	16	red	22	MS25036-107
P60F16	16	red	19	MS25036-107, MS25036-107
P60G16	16	red	20	MS25036-107
P67A16	16	red	19	MS25036-107, MS25036-107
P67B16	16	white	20	MS25036-107
P67C16	16	white	22	MS25036-107
P67B16	16	red	20	MS25036-107
P67C16	16	red	22	MS25036-107
X1A8	8	black		MS25036-115
X2A8	8	black		MS25036-115
X3A8	8	black		MS25036-115
X7A8	8	black		MS25036-115
X8A8	8	black		MS25036-115
X9A8	8	black		MS25036-115
X4A8	8	black	16	MS25036-115
X5A8	8	black	16.5	MS25036-115
X4A8	8	white	16	MS25036-115
X5A8	8	white	16.5	MS25036-115
X6A8	8	black	15	MS25036-115
X7B8	8	black	12	MS25036-115, MS25036-115
X7D16	16	black	13.5	MS25036-108, MS25036-153
X8B8	8	black	18	MS25036-115, MS25036-115
X8D16	16	black	19	MS25036-108, MS25036-153
X9B8	8	black	10	MS25036-115, MS25036-115
X9D16	16	black	17.5	MS25036-108, MS25036-153
X9E16	16	black	17	MS25036-108
X9L12	12	black	30	MS25036-112, MS25036-156
X10A8	8	black	17.5	MS25036-115
X10B8	8	black	21	MS25036-115, MS25036-115
X10D16	16	black	39	MS25036-153, MS25036-108
X11A8	8	black	19	MS25036-115
X11B8	8	black	15	MS25036-115, MS25036-115
X11D16	16	black	35	MS25036-153, MS25036-108
X12A8	8	black	20	MS25036-115
X12B8	8	black	19	MS25036-115, MS25036-115
X12D16	16	black	35	MS25036-153, MS25036-108
X12E16	16	black	21	MS25036-108
X12L12	12	black	32	MS25036-112, MS25036-156
X13B8	8	black	17	MS25036-115
X14B16	16	black	22	MS25036-108
X15B16	16	black	22.5	MS25036-108
X17B16	16	black	20	MS25036-108

Table 6-3. AC Output Control Box Wiring Harness (Cont)

Wire No.	Gauge	Marking Color	Length in Inches	Terminal Lugs
X21A12	12	black	10	MS25036-156, MS25036-156
X22A16	16	black	20	MS25036-153
X23A16	16	black	15.5	MS25036-153
X28A16	16	black	14	MS25036-153, MS25036-153
X29A16	16	black	19.5	MS25036-153
X30A16	16	black	14	MS25036-153, MS25036-107
X30B16	16	black	15	MS25036-107, MS25036-108
X30C16	16	black	32	MS25036-153, MS25036-107
X31A16	16	black	7	MS25036-107, MS25036-153
X31B16	16	black	22	MS25036-107
X32A16	16	black	16	MS25036-153, MS25036-108
X33A16	16	black	14.5	MS25036-153, MS25036-153
X34A16	16	black	17	MS25036-153
X34A16	16	black	19	MS25036-153
X36A16	16	black	28	MS25036-153, MS25036-153
X37A16	16	black	28	MS25036-153, MS25036-153
X38A16	16	black	25	MS25036-153, MS25036-153
X39A16	16	black	26	MS25036-153
X40A16	16	black	21	MS25036-153
X47A16	16	black	22	MS25036-107, MS25036-153
X48A16	16	black	20.5	MS25036-107, MS25036-153
X49A16	16	black	16	MS25036-107, MS25036-153
X76A16	16	black	16	MS25036-153, MS25036-108
X77A16	16	black	34	MS25036-153
X31F16	16	black	35	MS25036-107, MS25036-153

(4) AC Voltmeter (M5) (18, figure 6-3). Tag and disconnect two leads from meter. Remove three screws, nuts, and lockwashers attaching meter to control panel and remove meter.

d. Meters (replace).

(1) Frequency Meter (M3) (16, figure 6-3). Position meter in control panel and attach with three screws, lockwashers, and nuts. Connect the two electrical leads and remove tags.

(2) Frequency Transducer (A3) (56, figure 6-3). Position transducer to back of control cubicle and attach with four screws (54) and nuts (55). Connect the four electrical leads and remove tags.

(3) Percent Current Meter (M4) (17, figure 6-3). Position meter on control panel and attach with three screws, lockwashers and nuts. Attach the two electrical leads and remove tags.

(4) AC Voltmeter (M5) (18, figure 6-3). Position meter on control panel and attach with three screws, lockwashers, and nuts. Attach the two electrical leads and remove tags.

6-5. GENERATOR SET WIRING HARNESS.

a. Remove (see figure 6-2). Refer to figure 6-2 and remove wiring harness at terminal boards and connectors.

b. Repair. Replace wires and terminals as needed. See table 6-2.

6-6. VOLTAGE REGULATOR.

a. Test, on Equipment.

(1) Operate Generator Set at 120 volts, single phase load at 25%, 50%, 75% and 100% load.

(2) If L1 to L3 voltage deviates more than 5% over the load range, voltage regulator is defective.

b. Inspect (see figure 6-3).

(1) Drop the control box panel (28) by loosening fasteners (9) to expose the voltage regulator (39).

(2) Visually inspect the voltage regulator for poor connection or burned or open components or cracked circuit board.

c. Remove.

(1) Tag and disconnect harness leads to voltage regulator (39).

(2) Remove nuts (38) attaching voltage regulator from control box (57) and remove voltage regulator.

d. Test, Bench (see figure 6-4).

(1) Connect ac voltage regulator to test circuit and test as shown in figure 6-4. Transformers T₁ and T₂ are located in the control cubicle (see figure 6-3, items 34 and 37) and may be disconnected and used for this test.

(2) Perform the test and calibration procedures shown in figure 6-4.

(3) Failure of the voltage regulator to meet the test and calibration requirements indicates the voltage regulator should be replaced.

e. Repair. See voltage regulator schematic diagram, figure 6-5.

(1) Repair of the voltage regulator is limited to replacing defective components. Refer to the schematic figure 6-5 for proper values.

f. Installation (see figure 6-3).

(1) Mount serviceable voltage regulator (39) into the control box (57) using nuts (38).

(2) Reconnect previously tagged and removed harness to the voltage regulator terminal board.

6-7. AC OUTPUT CONTROL BOX WIRING HARNESS.

Install and repair wiring harness by replacing wires, connectors, and terminal lugs as necessary. See figure 6-6 and table 6-3 for all necessary wiring harness assembly.

6-8. AC OUTPUT CONTROL BOX ASSEMBLY.

a. Test, on Equipment.

(1) Resistor R3 (20, figure 6-10) must be adjusted as follows before performing any tests.

(2) Remove wire D26F16 from TB3-1 and connect 0 to 1 amp ac ammeter. Connect test ammeter as shown in figure 6-7.

(3) Place reconnection switch in 120 $\emptyset$ position.

(4) With the generator operating at rated speed (1800 RPM) apply rated load by closing circuit breaker (CB1) (9, figure 6-10).

(5) Adjust R3 until ammeter previously installed reads 0.6 amps, tighten locknut on R3. R3 is now adjusted properly.

(6) Disconnect test equipment and proceed with testing in accordance with test schedule.

NOTE

Because the proper connection of certain ac output control box circuits can only be determined by its ability to function properly when operated in conjunction with the control cubicle, it is imperative that the control cubicle supplied be complete and is functioning properly for all tests.

(7) With the unit running normally, test control box assembly by measuring voltage at load terminals with the reconnection switch in each of its three positions. See table 6-4.

b. Remove (see figure 6-8). Remove electrical connector plugs from connectors (2) on side of control box (1). Remove two screws (3), lockwashers (4), bevel washers (5), lockwashers (6) and nuts (7). Remove four screws (8) and washers (9) attaching box to skid-base (10) and remove control box (1).

c. Install. Mount control box (1) to skid-base (10) using screws (8), washers (9) and screws (3), lockwashers (4), bevel washers (5), lockwashers (6) and nuts (7). Reconnect plugs to connectors (2).

6-9. AC OUTPUT CONTROL BOX (INTERNAL COMPONENTS).

WARNING

Before working on the load terminal board or other devices associated with the ac control box make certain that the Generator Set is not operating, all switches are in the OFF or OPEN position, and there is no input to the load.

Table 6-4. Terminal Voltages

Switch Position	Measure Across	Correct Voltage
120 V, 1 Phase	L1-L3	120 vac
120/240 V, 1 Phase	L0-L1	120 vac
	L0-L3	120 vac
	L1-L3	240 vac
120/208 V, 3 Phase	L0-L1	120 vac
	L0-L2	120 vac
	L0-L3	120 vac
	L1-L2	208 vac
	L2-L3	208 vac
	L1-L3	208 vac

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Figure 6-3. Control Cubicle (Sheet 1 of 2)

1. Screw	20. Rheostat	39. Regulator
2. Nut	21. Switch	40. Link
3. Holder	22. Switch	41. Screw (2)
4. Terminal (2)	23. Switch	42. Nut (2)
5. Hook	24. Screw (2)	43. Relay
6. Screw	25. Circuit breaker	44. Screw (2)
7. Nut	26. Nut (4)	45. Nut (2)
8. Clamp	27. Screw (4)	46. Panel assembly
9. Fastener pin (3)	28. Panel	47. Screw (4)
10. Grommet (3)	29. Nut	48. Nut (4)
11. Stud (3)	30. Screw	49. Screw (4)
12. Battery indicator	31. Strap	50. Nut (4)
13. Lampholder (2)	32. Screw (2)	51. Screw (4)
14. Lamp (2)	33. Nut (2)	52. Nut (4)
15. Hourmeter	34. Transformer	53. Wiring harness
16. Frequency meter	35. Screw (4)	54. Screw (4)
17. Percent rated current meter	36. Nut (4)	55. Nut (4)
18. AC Voltmeter	37. Transformer	56. Frequency transducer
19. Knob (3)	38. Nut (4)	57. Control box

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Figure 6-3. Control Cubicle (Sheet 2 of 2)

a. Inspect.

(1) Load Terminal Board (TB1). Inspect the load terminal board (10, figure 6-9) for physical damage. Inspect the terminals for bad threads and security of connections.

(2) Reconnection Switch (S6) (see figure 6-10). Inspect reconnection switch (1) for physical damage. Check that switch is securely attached to control box (2) with four screws (3) and lockwashers (4) in front and with two screws (5), spacers (6), lockwashers (7) and nuts (8) in back. Check that electrical connections to switch are clean and tight.

(3) AC Circuit Breaker (CB1) (see figure 6-10). Inspect main circuit breaker (9) for physical damage. Check that twelve electrical connections to breaker are clean and tight. Check that breaker is securely fastened to output control box.

(4) Printed Circuit Board Bridge Assembly (see figure 6-9). Remove four screws (11) and lockwashers (12) attaching side access panel (13) to output control box (24) and remove panel. Inspect printed circuit board (23) and components for physical damage. Check that the assembly is clean and securely attached to output control box. Check that electrical connections to board are clean and tight.

(5) 15 Amp Circuit Breaker (CB3) (see figure 6-10). Inspect 15 amp circuit breaker (11) for physical damage. Check that two electrical connections to breaker are clean and tight. Check that breaker is securely attached to output control box (2).

(6) Convenience Receptacle (J14) (see figure 6-10). Inspect convenience receptacle (13) for char-

ring or other physical damage. Check that two electrical connections to receptacle are clean and tight. Check that receptacle is securely fastened to front panel of output control box (2) with two screws (18) and nuts (19). Check that receptacle cover (16) and gasket (17) are securely attached to panel and that cover operates properly.

(7) Linear Reactor (L1) (see figure 6-9). Inspect linear reactor (15) for physical damage. Check that electrical connections are clean and tight. Check that reactor is securely attached to side panel of output control box.

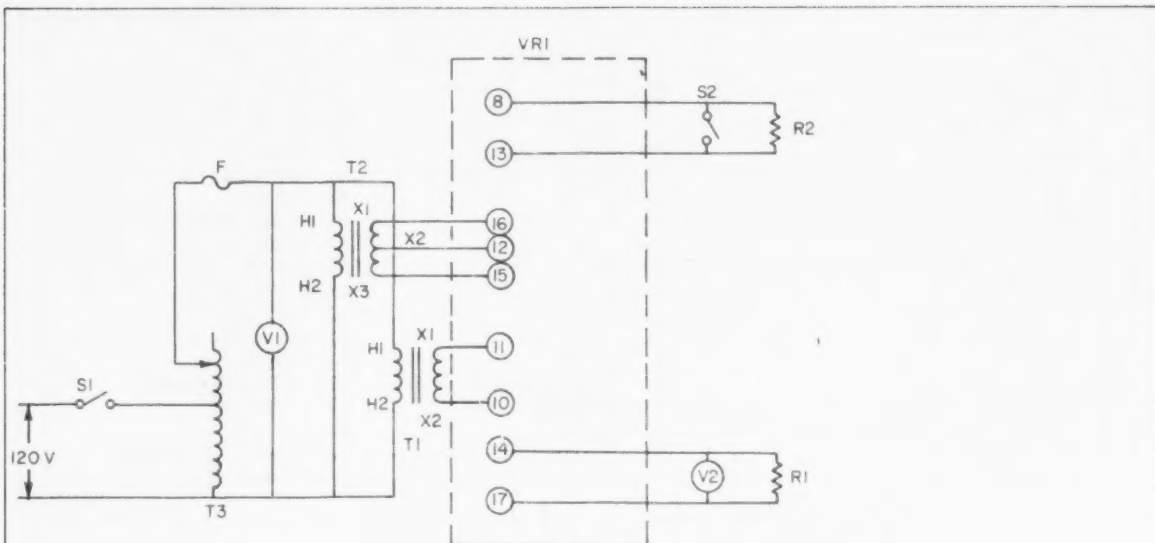
(8) Connector Assemblies (see figure 6-9). Inspect each of the four connector assemblies (18 and 21) mounted to side of output control box for corrosion or physical damage. Check that each connector assembly is securely mounted to side panel of output control box.

(9) Current Voltage Transformer (CVT1) (see figure 6-9). Inspect transformer (6) for physical damage. Check that electrical connections to transformer are clean and tight.

(10) Current Transformer (CT1) (see figure 6-9). Inspect transformer (7) for physical damage. Check that electrical connections to transformer are clean and tight.

(11) Wiring Harness Assembly. Inspect wiring harness for broken wires. Check for frayed or deteriorated insulation. Check that all terminal points are clean, tight, and free of damage.

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ITEMS NEEDED FOR TEST CIRCUIT

- T 1 = TRANSFORMER - 72-5004
- T 2 = TRANSFORMER - 72-5005
- T 3 = TRANSFORMER - VARIABLE 4 AMP 0-150V
- V 1 = VOLTMETER AC - 0-150V $\pm$ 2% @ 150V
- V 2 = VOLTMETER DC - 0-15V $\pm$ 2% FULL SCALE
- R 1 = RESISTOR - 10 OHMS 20 WATT
- R 2 = RESISTOR - 2500 OHMS 2 WATT
- F 1 = FUSE - 5 AMP
- S 1 = SWITCH - 250V 5A AC MIN
- S 2 = SWITCH - 250V 1A AC MIN

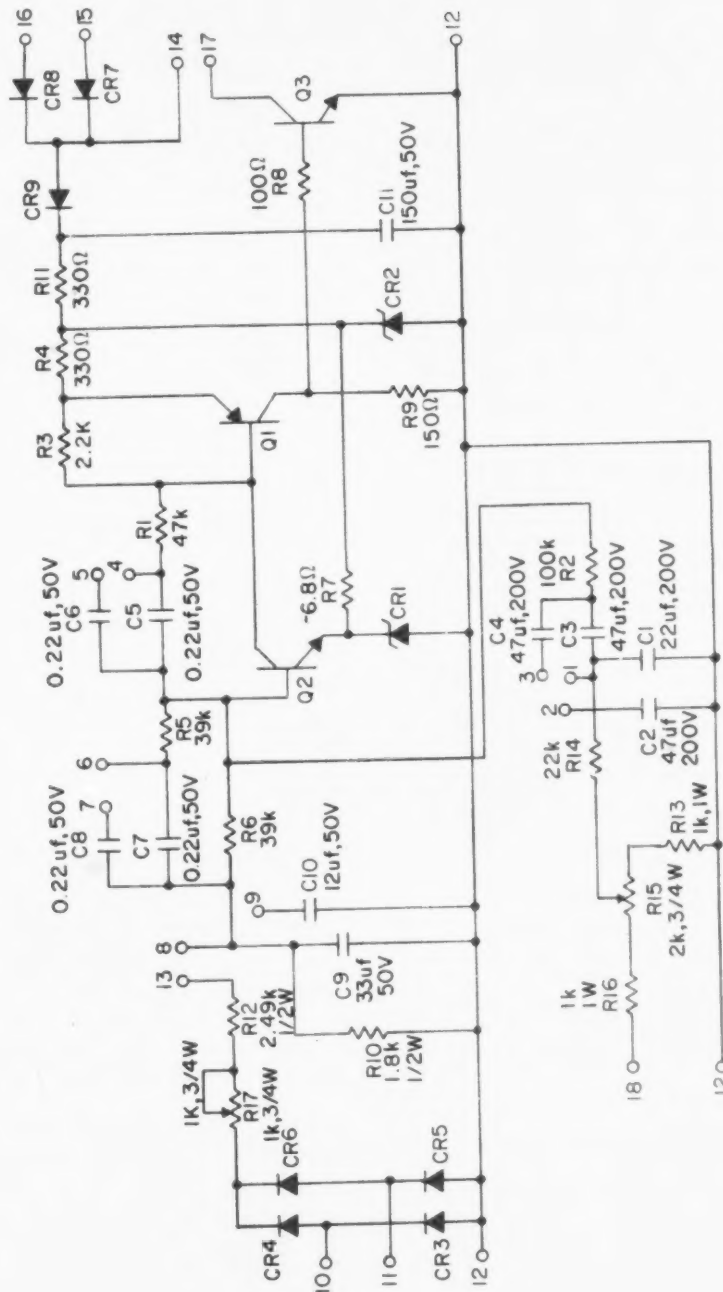
TEST AND CALIBRATION

V₁ - AC INPUT VOLTAGE
 V₂ - DC OUTPUT VOLTAGE

Step No.	Test Name	Switch Positions		Procedure	Requirements
		S1	S2		
1	Off	Off	Off	Connect Regulator as Shown	
2	Turn On	On	On	V ₁ Set at 120 Volts	V ₂ Minimum 6 Volts
3	Turn Off	On	Off	V ₁ Set at 120 Volts	V ₂ Maximum 1 Volt
4	Voltage Calibration	On	On	(A) V ₁ Set at 114 Volts	(A) Adjust R17 until V ₂ is 3 ± 1 Volts
5	Range	On	Off	V ₁ Set at 127 Volts	V ₂ Maximum 1 Volt
6	Off	Off	Off	Calibration Completed	

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Figure 6-4. Testing Voltage Regulator



R1 through R17 Resistors
 C1 through C11 Capacitors
 CR1 through CR9 Diodes
 Q1 through Q3 Transistors

NOTE:
 ALL RESISTORS ARE 1/2W
 UNLESS NOTED.

Figure 6-5. AC Voltage Regulator Schematic

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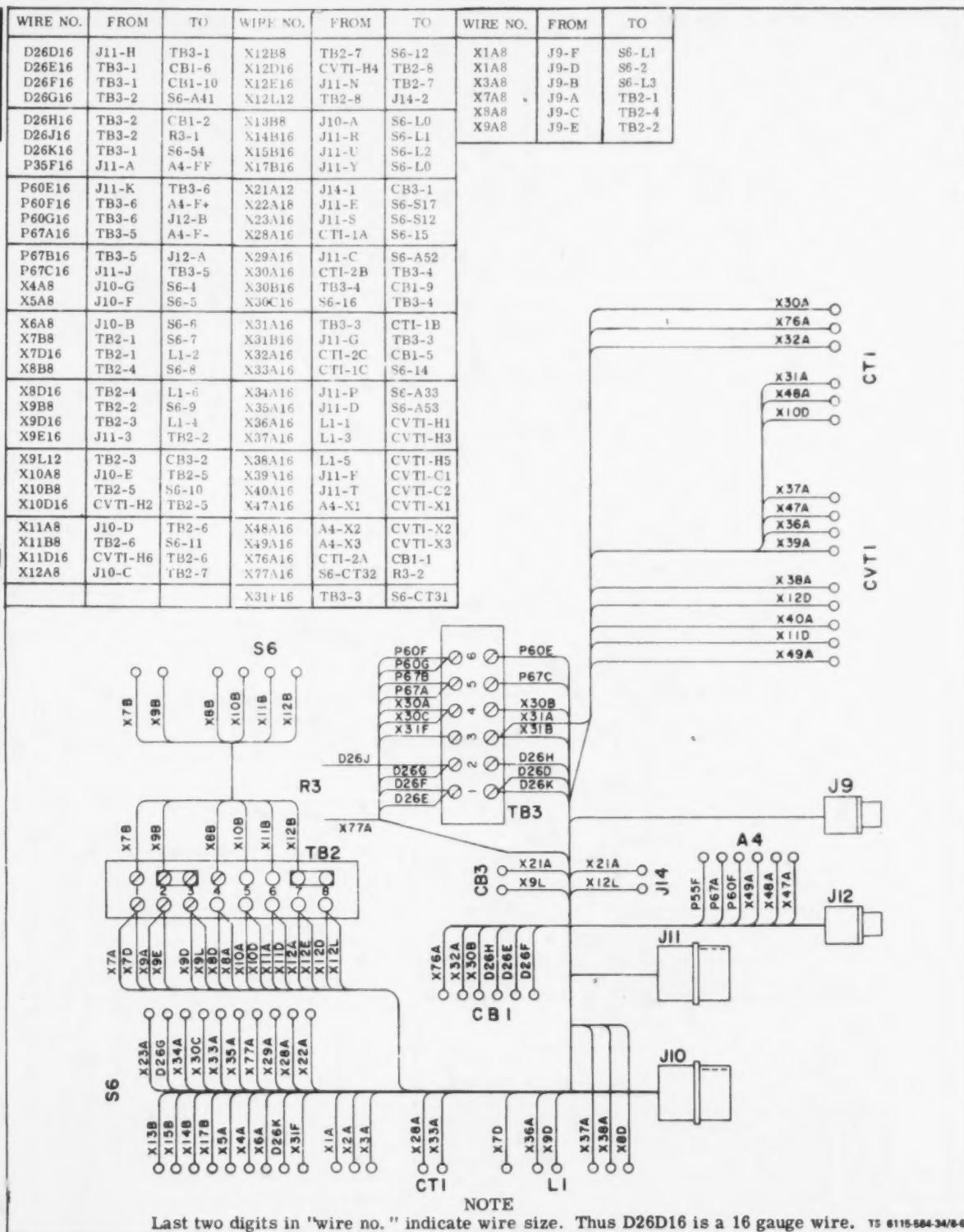


Figure 6-6. AC Output Control Box Wiring Harness

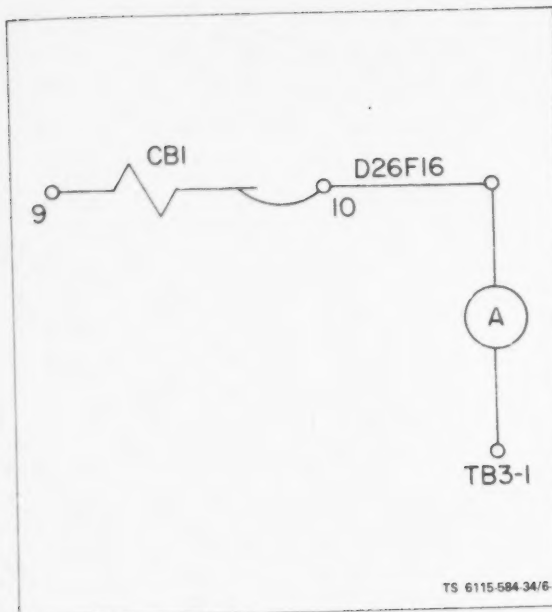


Figure 6-7. AC Output Control Box Test Setup

(12) Output Control Box Housing (24, figure 6-9). Inspect output control box housing for physical damage. Check that all hinges, covers, and latches operate properly. Check that all nameplates are in place. Check that side access cover is always in place when box is not being actively serviced.

b. Test.

(1) Reconnection Switch (S6) (1, figure 6-10). Tag and disconnect electrical connections except jumper wires from reconnection switch. Using an ohmmeter check for continuity between terminals listed in table 6-5 for each of the three switch positions. If continuity is not found for each pair of terminals listed, replace reconnection switch. If continuity is found between any other terminals switch should be replaced.

(2) AC Circuit Breaker (CB1). Test that breaker will remain in both the ON and OFF positions.

(3) 15 Amp Circuit Breaker (CB3). Test that breaker will remain in both the set (pushed) and tripped (pulled) positions.

(4) Convenience Receptacle (J14). With 15 amp circuit breaker in proper operating position, test convenience receptacle using a 120 volt trouble light or voltmeter. With the unit operating and the 15 amp circuit breaker pushed in, 120 volts should be present at the receptacle.

(5) Linear Reactor (L1). Disconnect electrical connectors from control box. Use an ohmmeter to

check resistance of each of the three windings in the reactor by checking resistance between terminals 1 and 2, 3 and 4, 5 and 6. Resistance for each winding must be 13.5 ohms plus or minus 1.35, if not replace reactor.

(6) Connector Assemblies. Test for continuity between each pin and case for shorts to ground.

(7) Current Voltage Transformer (CVT1). Using an ohmmeter check three primary windings of transformer (6, figure 6-9) by measuring resistance from terminals H1 to H2, H3 to H4, H5 to H6. Resistance must be 2.27 ohms $\pm$ 0.227 ohms. Check resistance in three secondary windings of transformer by checking from terminals X1 to X2, X1 to X3, X2 to X3. Resistance must be 1.68 ohms $\pm$ 0.168 ohms. Check resistance in control windings by checking from terminals C1 to C2. Resistance must be 9.6 ohms $\pm$ 0.96 ohms. If any of the windings do not show the proper resistance, replace transformer.

(8) Current Transformer (CT1). On the current transformer (7, figure 6-9) only the secondary windings can be checked. Using an ohmmeter check resistance in secondary windings by checking from terminals 1A to 2A, 1B to 2B, 1C to 2C. Resistance must be 0.5 ohms $\pm$ 0.05 ohms. If any of the windings do not show the proper resistance, replace transformer.

(9) Bridge Rectifier Assembly (A4) (see figure 6-11). Tag and remove leads to terminal board and test each diode (3) separately by checking between terminals (6) shown in table 6-6. Resistance in one direction should be very high in one direction and very low in the other. Measure resistance of R1 (4). It should be 56 ohms.

Table 6-5. Reconnection Switch Continuity

Switch Position	Check for Continuity Between Terminals
120V, 1 Phase	L1-12 L3-5 4-8
120/240V, 1 Phase	L1-12 L3-11 2-4 7-9 8-10
120/208V, 3 Phase	L0-4 L1-7 L2-2 L3-9

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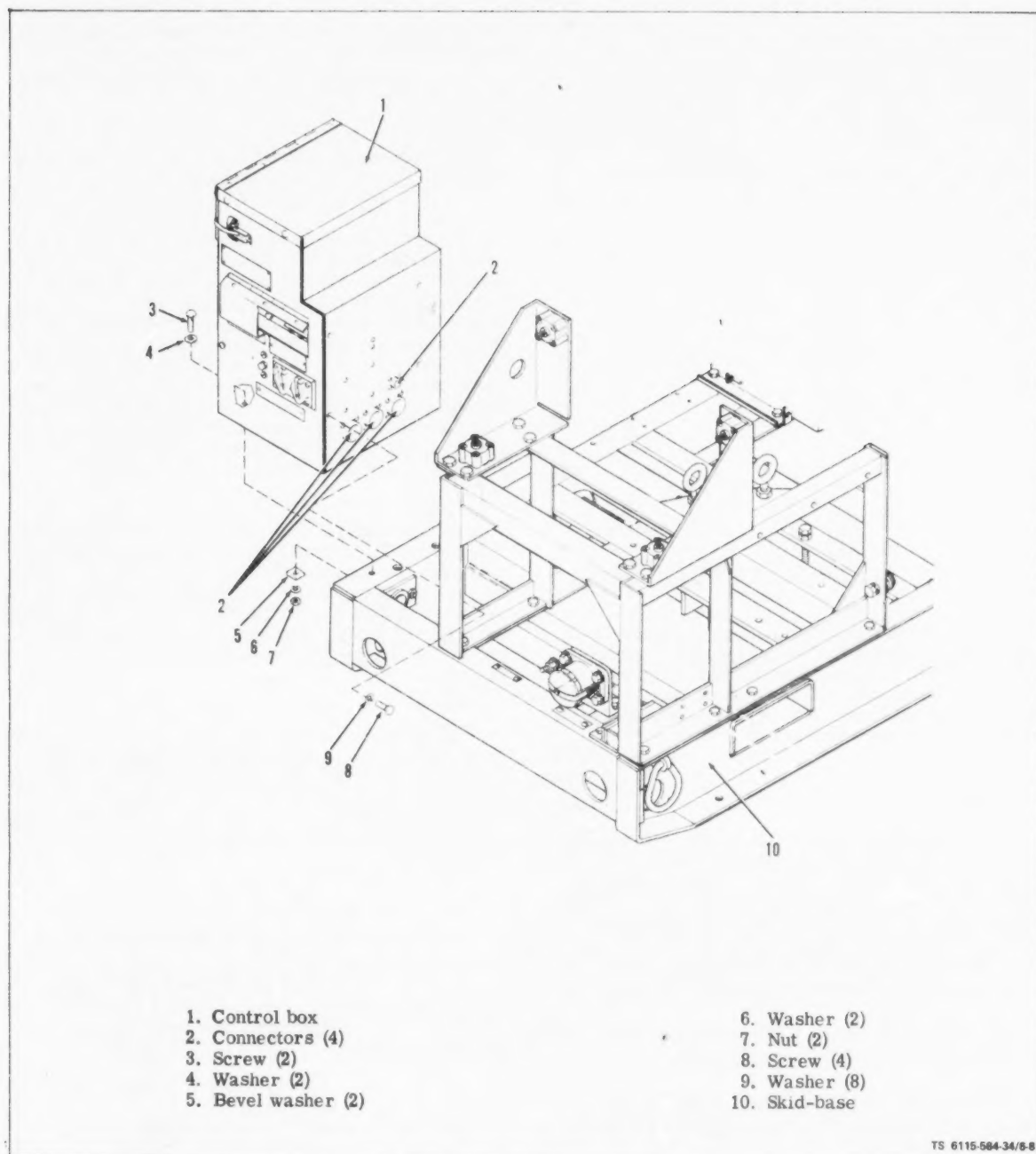


Figure 6-8. AC Control Box Removal

Table 6-6. Testing Bridge Assembly

To Test Diode	Check Resistance in Both Directions Between Terminals
A4-CR1	2-5
A4-CR2	1-5
A4-CR3	3-5
A4-CR4	2-4
A4-CR5	1-4
A4-CR6	3-4

c. Removal.

(1) Reconnection Switch (S6) and Transformers (CT1 and CVT1). Due to the large number of wires connected to these items, they are removed from the control box with the wiring connected. Remove screw (3, figure 6-10) and lockwashers (4). Remove screws (5), nuts (8), lockwashers (7) and spacers (6). Remove switch (1) and wiring. Remove transformers (6 and 7, figure 6-9) by removing screws (1), nuts (3) and lockwashers (2). Tag and remove wiring from transformers and switch. Disassemble transformers by removing screws (4) and nuts (5).

(2) Load Terminal Board (TB1) (see figure 6-9). Disconnect load from load terminal board. Remove six screws (8) and lockwashers (9), attaching board (10) to control box (24) and remove board. Tag and disconnect four wires to load terminals (25).

(3) AC Circuit Breaker (CB1). Remove side access panel (13, figure 6-9) by removing screws (11) and lockwashers (12). Tag and remove leads connected to circuit breaker (9, figure 6-10). Remove six screws (10) attaching breaker (9) to front panel (2) and remove breaker.

(4) 15 Amp Circuit Breaker (CB3) (see figure 6-10). Remove side access panel (13, figure 6-9). Tag and disconnect two electrical leads to 15 amp circuit breaker (11, figure 6-10). Remove

two screws (12) attaching breaker to front panel of output control box (2) and remove breaker.

(5) Convenience Receptacle (J14). Remove four screws (11, figure 6-9) and lockwashers (12) attaching side access cover (13) to output control box and remove cover. Remove four screws (14, figure 6-10) and nuts (15) attaching receptacle cover to front panel and remove cover (16) and gasket (17). Tag and disconnect two leads from receptacle. Remove two screws (18) and nuts (19) attaching receptacle to front panel and remove receptacle (13). Disconnect two leads from the receptacle and tape each lead end, separately (figure 1-7).

(6) Linear Reactor (L1) (see figure 6-9). Remove side access panel (13). Tag and disconnect six leads to linear reactor (15). Remove four screws (14) attaching reactor to side panel of output control box and remove reactor.

(7) Connector Assemblies (see figure 6-9). Remove screws (16 and 19) and nuts (17 and 20) attaching connectors (18 and 21) to output control box and remove connector. Tag and disconnect wires from wiring harness to connector. Reconnect tagged wires to new connector.

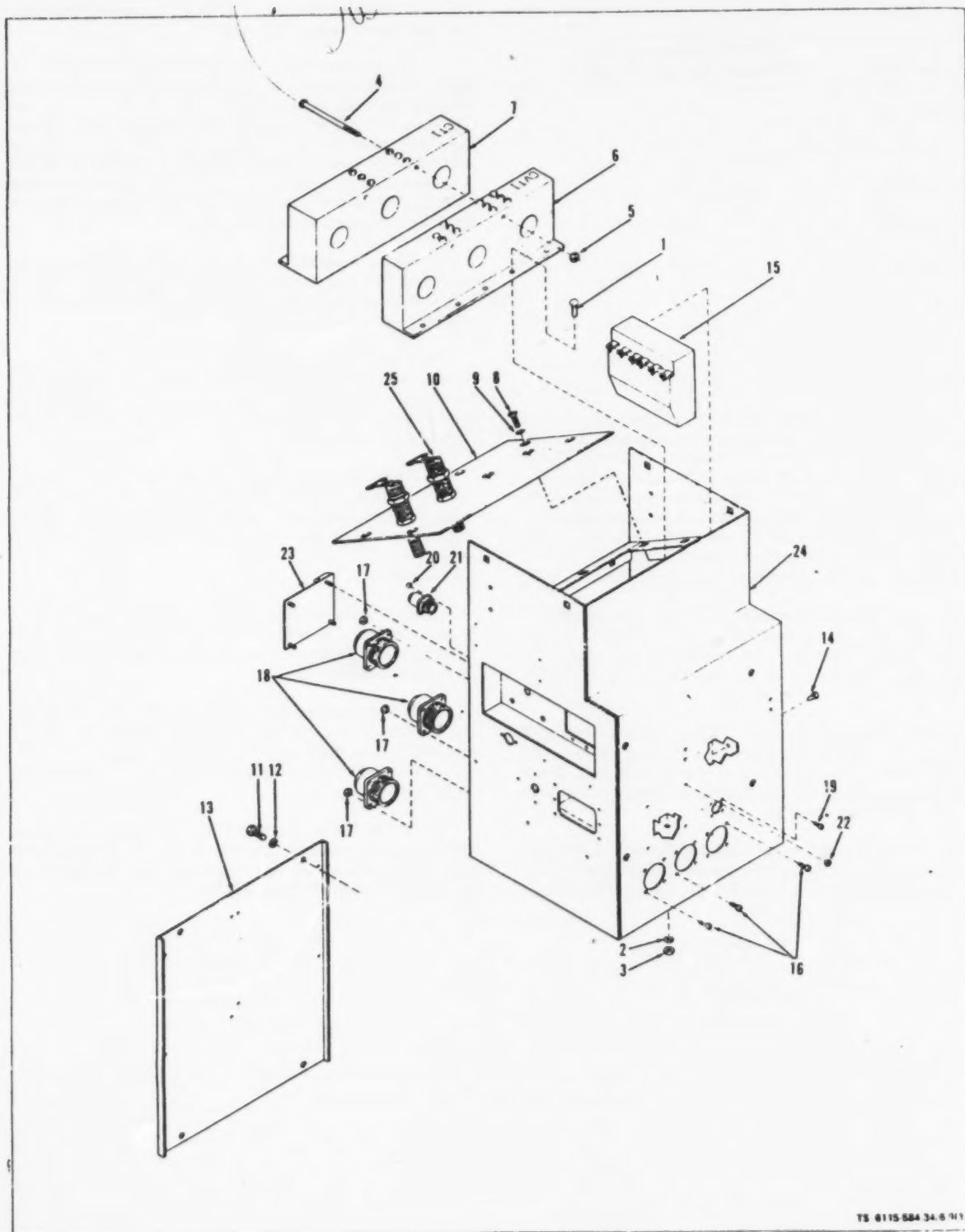
(8) Bridge Rectifier Assembly (see figure 6-9). Tag and remove leads to rectifier assembly (23). Remove nuts (22) holding bridge assembly to ac output control box and remove bridge assembly. Replace bad diodes or resistors as necessary.

d. Install.

(1) Load Terminal Board (TB1). Attach four tagged wires to load terminals per wiring diagram, figure 1-7. Attach load terminal board (10, figure 6-9) to control box (24) with six screws (8) and lockwashers (9).

(2) AC Circuit Breaker (CB1) (see figure 6-10). Attach circuit breaker (9) to front panel of output control box with six screws (10). Attach six tagged leads to terminals 3, 4, 7, 8, 11, and 12 of breaker per wiring diagram, figure 1-1. Replace side access panel.

(3) 15 Amp Circuit Breaker (CB3) (see figure 6-10). Attach new breaker (11) to front panel of output control box (2) with two screws (12). Attach two tagged leads to 15 amp circuit breaker per wiring diagram, figure 1-1.



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Figure 6-9. AC Output Control Assembly (Sheet 1 of 2)

- | | |
|-------------------------|-------------------------------|
| 1. Screw (10) | 14. Screws (4) |
| 2. Lockwasher (10) | 15. Linear reactor |
| 3. Nut (10) | 16. Screw (12) |
| 4. Screw (2) | 17. Nut (12) |
| 5. Nut (2) | 18. Connector (3) |
| 6. Transformer | 19. Screw (4) |
| 7. Transformer | 20. Nut (4) |
| 8. Screw (6) | 21. Connector |
| 9. Lockwasher (6) | 22. Nut (4) |
| 10. Load terminal board | 23. Bridge rectifier assembly |
| 11. Screw (4) | 24. Output control box |
| 12. Lockwasher (4) | 25. Load terminal (4) |
| 13. Access panel | |

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Figure 6-9. AC Output Control Assembly (Sheet 2 of 2)

(4) Convenience Receptacle (J14) (see figure 6-10). Attach new receptacle (13) to front panel with two screws (18) and nuts (19). Attach receptacle cover (16) and gasket (17) to front panel with four screws (14) and nuts (15). Attach two tagged leads to receptacle per wiring diagram, figure 1-1.

(5) Linear Reactor (L1) (see figure 6-9). Attach new reactor (15) to side panel with four screws (14). Connect six tagged leads to reactor per wiring diagram, figure 1-1.

(6) Connector Assemblies (see figure 6-9). Attach connectors (18 and 21) to output control box with screws (16 and 19) and nuts (17 and 20).

NOTE

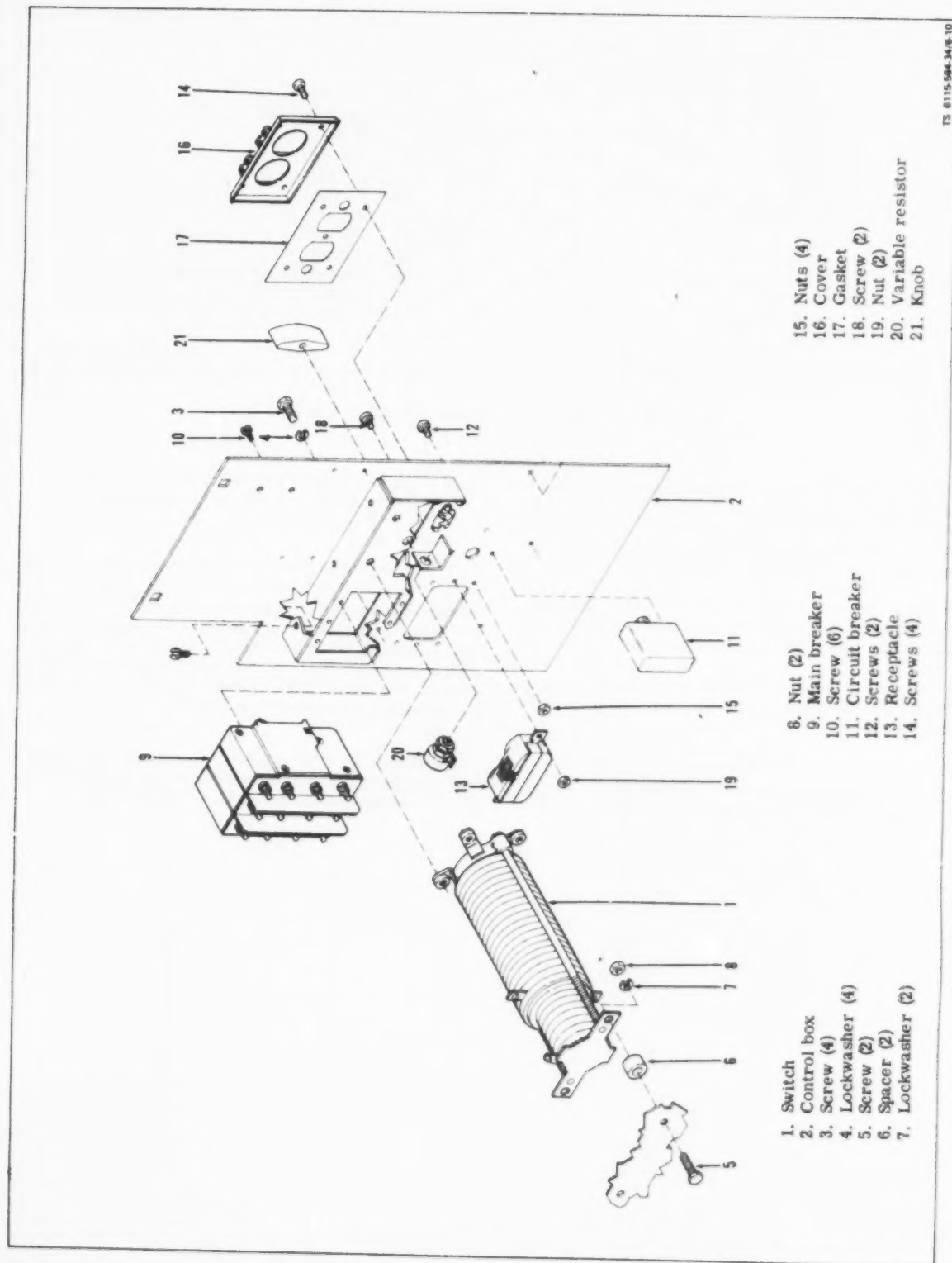
If any difficulty is encountered in reconnecting the jumpers to the reconnection switch,

refer to either Figure 6-10.1 or 6-10.2 according to the part number of the switch used.

(7) Reconnection Switch (S6) and Transformers (CT1 and CVT1). Assemble transformers (6 and 7, figure 6-9) with screws (4) and nuts (5). Attach tagged wires to transformers and reconnection switch (1, figure 6-10). Refer to wiring diagram, figure 1-1. Install transformers (6 and 7, figure 6-9) with screws (1), nuts (3) and lockwashers (2). Install reconnection switch (1, figure 6-10) with screw (3), lockwasher (4), screw (5), spacer (6), lockwasher (7) and nut (8).

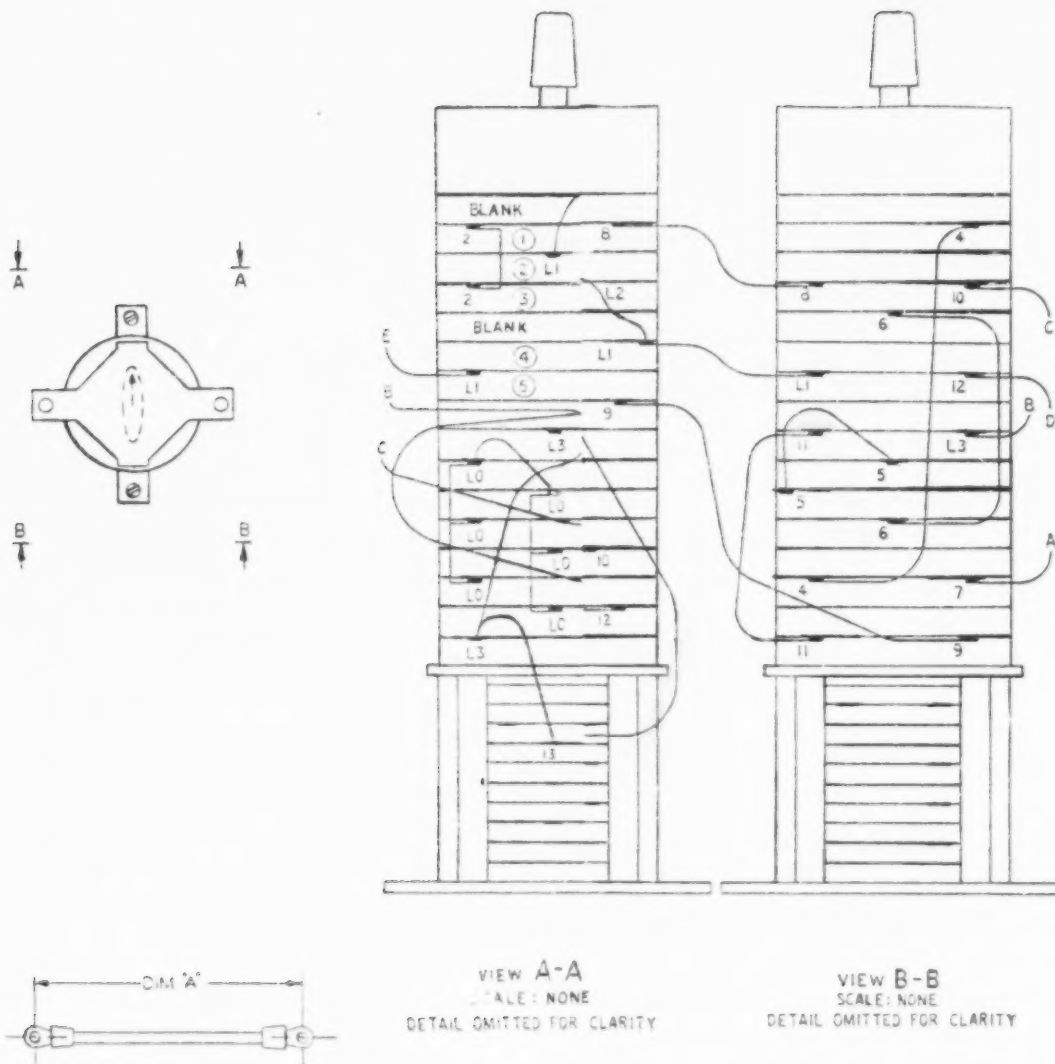
(8) Bridge Rectifier Assembly (see figure 6-9). Position bridge assembly (23) to ac output control box and attach with nuts (22). Connect electrical leads and remove tags.

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Figure 6-10. AC Output Control Assembly (Switch, Receptacle and Circuit Breaker)



FROM	TO	DIM "A"	WIRE FIND NO.	TERMINAL FIND NO.
B SECT 1	B SECT 3	6.00	2	4
L1 SECT 2	L1 SECT 4	8.00	2	4
4 SECT 1	4 SECT 11	10.00	2	4
6 SECT 2	6 SECT 9	8.00	2	4
10 SECT 3	10 SECT 10	8.00	2	4
L1 SECT 4	L1 SECT 5	6.00	2	4
7 SECT 4	7 SECT 11	8.00	2	4
12 SECT 5	12 SECT 12	6.00	2	4
11 SECT 6	11 SECT 13	7.00	2	4
L3 SECT 6	L3 SECT 7	6.00	2	4
L3 SECT 7	L3 SECT 4	6.00	2	4
5 SECT 7	5 SECT 8	6.00	2	4
L0 SECT 8	L0 SECT 9	6.00	2	4
L3 SECT 14	L3 SECT 17	5.00	3	5, 6
9 SECT 14	9 SECT 13	6.00	2	4

Figure 6-10.1 Switch Assembly, Rotary

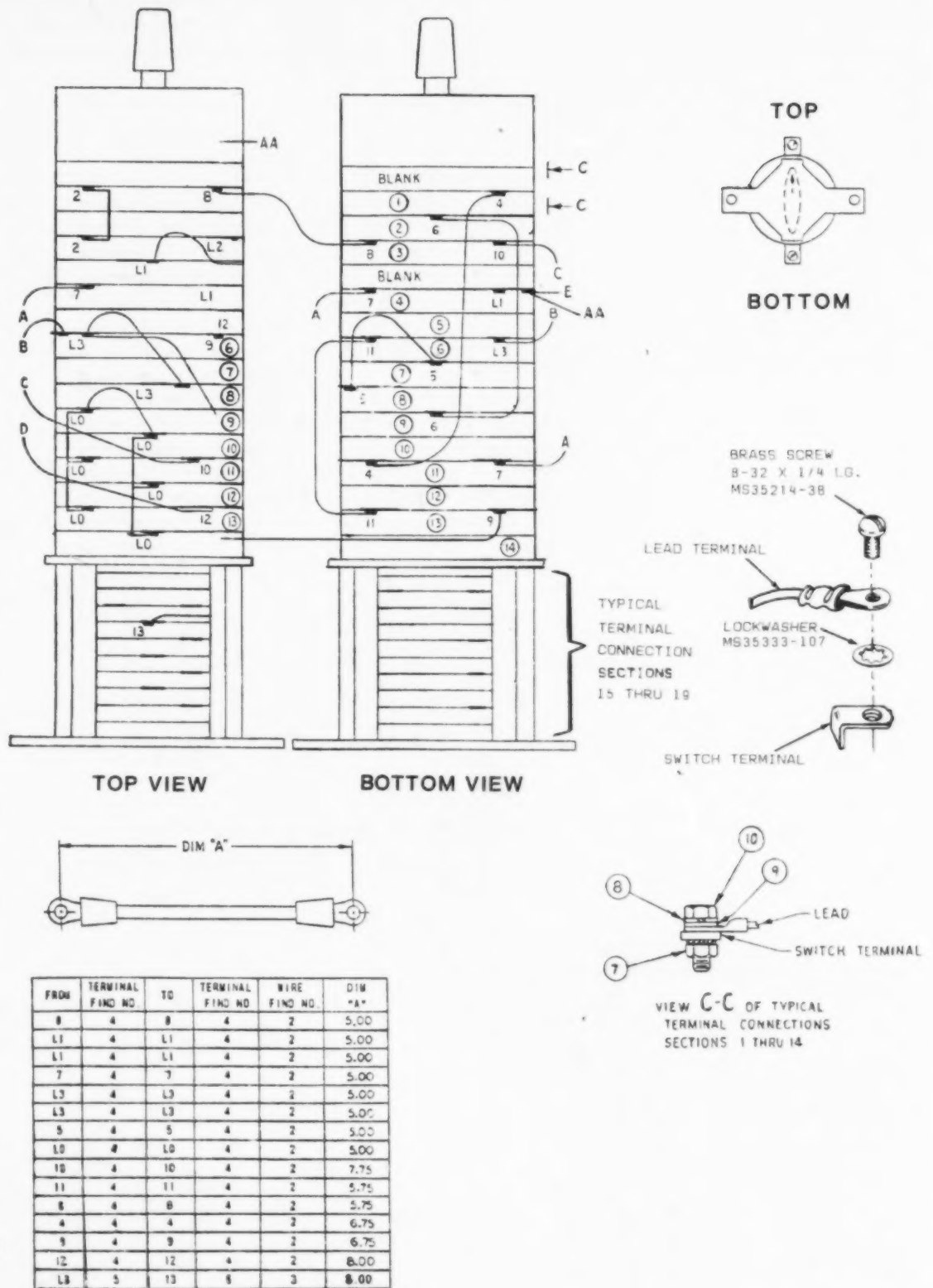


Figure 6-10.2 Switch Assembly, Rotary

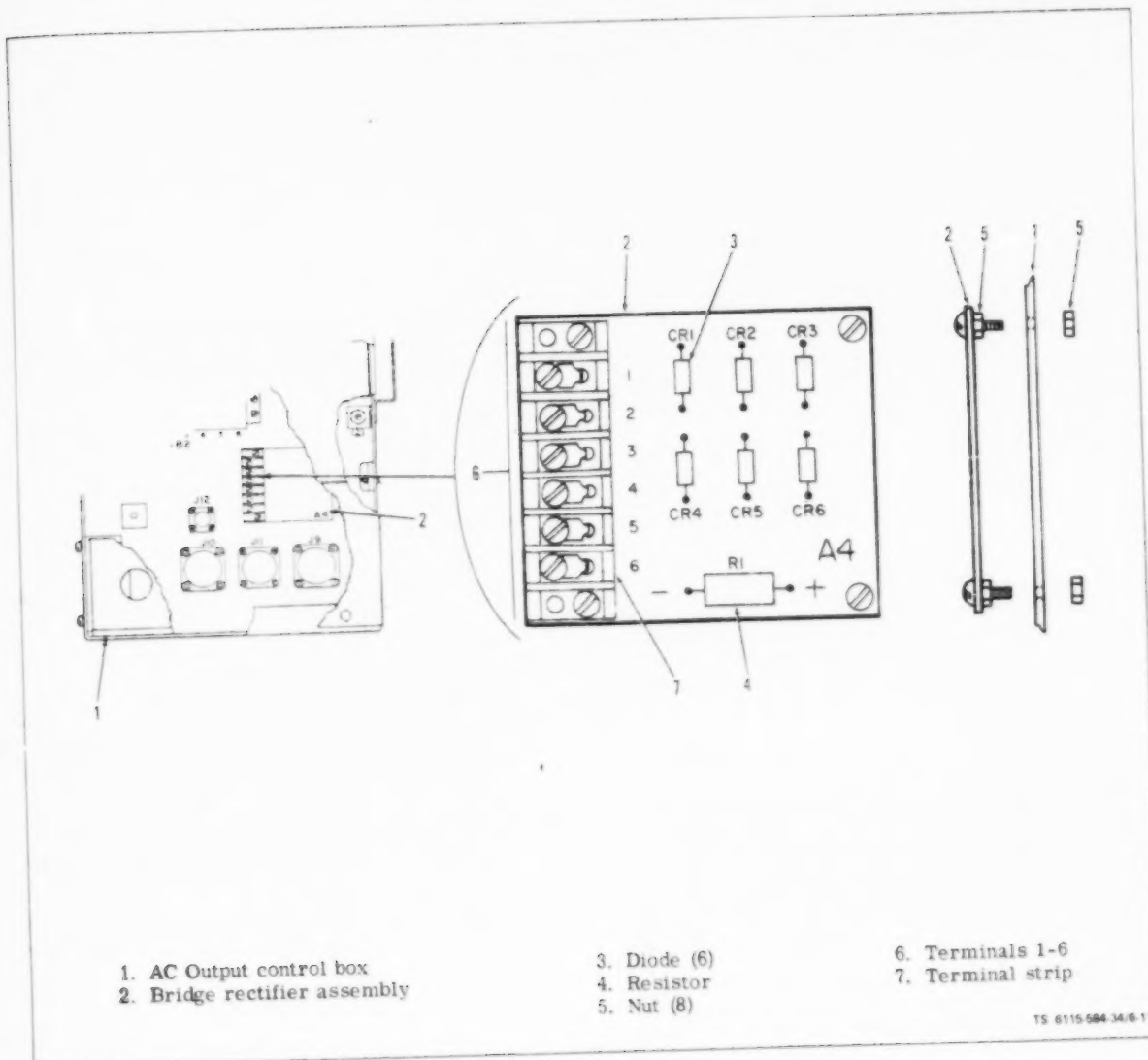


Figure 6-11. Bridge Rectifier Assembly A-4

CHAPTER 7 MAINTENANCE OF ENGINE

Section I. DESCRIPTION AND FUNCTION

7-1. GENERAL.

The engine is a two cylinder, air-cooled, overhead valve, fuel injected, diesel. End crankshaft and camshaft bearings are press fit one piece bearings. Crankshaft end play is adjusted

by using correct shim between rear bearing plate and cylinder block. One piece, press fit oil seals are used to seal both ends of crankshaft. A mechanical governor is used to regulate engine speed under varying generator load conditions. Since the engine is direct coupled to the generator, 1800 RPM engine speed produces 60 Hz generator output.

Section II. ENGINE EXTERNAL ASSEMBLY

7-2. FUEL LINES.

CAUTION

Cap, plug, or tape all fuel lines and fittings as well as injector and pump openings to keep dirt from entering fuel system.

a. Removal. Tag and remove injector nozzle return lines (3, figure 7-1). Remove manifold (4) and return line (5). Tag and remove injector lines (7).

b. Inspection. Inspect lines and fittings for thread damage and breaks which might cause leaks.

NOTE

For Torque information on fuel line fittings see Table 1-1.

c. Installation. Remove plugs or tape from lines and fittings. Contaminated lines and fittings should be rinsed with clean fuel oil before installation. Install injector lines (7, figure 7-1) between injector pump (1) and injector nozzles (2). Remove tags. Install return line (5) and manifold (4). Install fittings (6) on injector nozzles (2) and install return lines (3) between fittings (6) and manifold (4). Remove tags.

7-3. EXTERNAL GOVERNOR PARTS AND SPEED CONTROL ASSEMBLY.

a. Inspect (see figure 7-2). Inspect governor linkage and springs for physical damage, binding or excessive slack or wear. Check that linkage is clean and free of dirt, grease, or oil or other obstructions. Check that governor linkage moves freely. Check ball joints for smooth but not loose fits.

b. Test. Operate engine until it reaches normal operating

c. Adjust.

(1) Low Speed Adjustment. Adjust low speed (1800 RPM) by repositioning the control nut (7, figure 7-2) at the attaching bracket located inside the engine access door. The control knob should be pushed fully in before making the low speed adjustment. This reduces tension on the spring (17) permitting governor arm (3) to move the injector pump (2) to lower fuel position reducing engine speed.

(2) High Speed Adjustment. Adjust high speed (2250 RPM) by setting the maximum speed stop screw (18), located at the front of the engine (clockwise lowers speed, counterclockwise increases speed) with the control knob pulled fully out. The control knob can then be intermediately positioned for 61.5 Hz (no load) operation.

(3) Sensitivity Adjustment. Adjust governor sensitivity (no load to full load speed droop) by turning the sensitivity adjusting ratchet (16) counterclockwise (lower spring) for more sensitivity (less speed droop when full load is applied) or clockwise (raise spring) for less sensitivity (more speed droop when full load is applied). If the governor is too sensitive, a rapid hunting condition occurs (alternate increasing and decreasing of speed). Adjust for maximum sensitivity without hunting.

d. Remove. Disconnect governor linkage (1) from injector pump (2) and governor arm (3). Remove governor arm (3) and governor shaft (4). Remove cotter pin (5) and pin (6). Loosen nuts (7) and (8). Remove clamp (10). Remove speed control cable (11). Remove control bracket (12) from engine back plate by removing screw (13), lockwasher (14) and nut (15).

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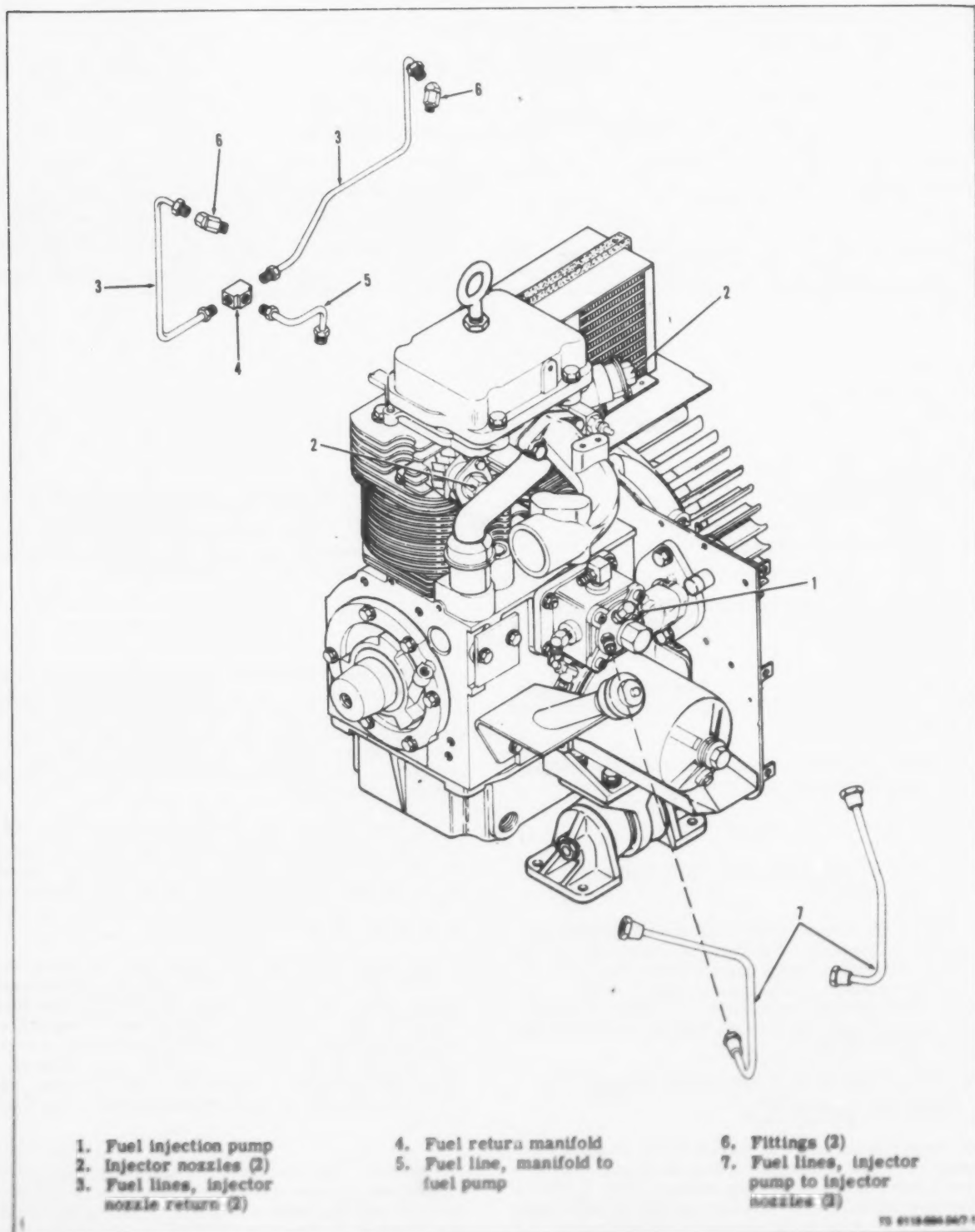
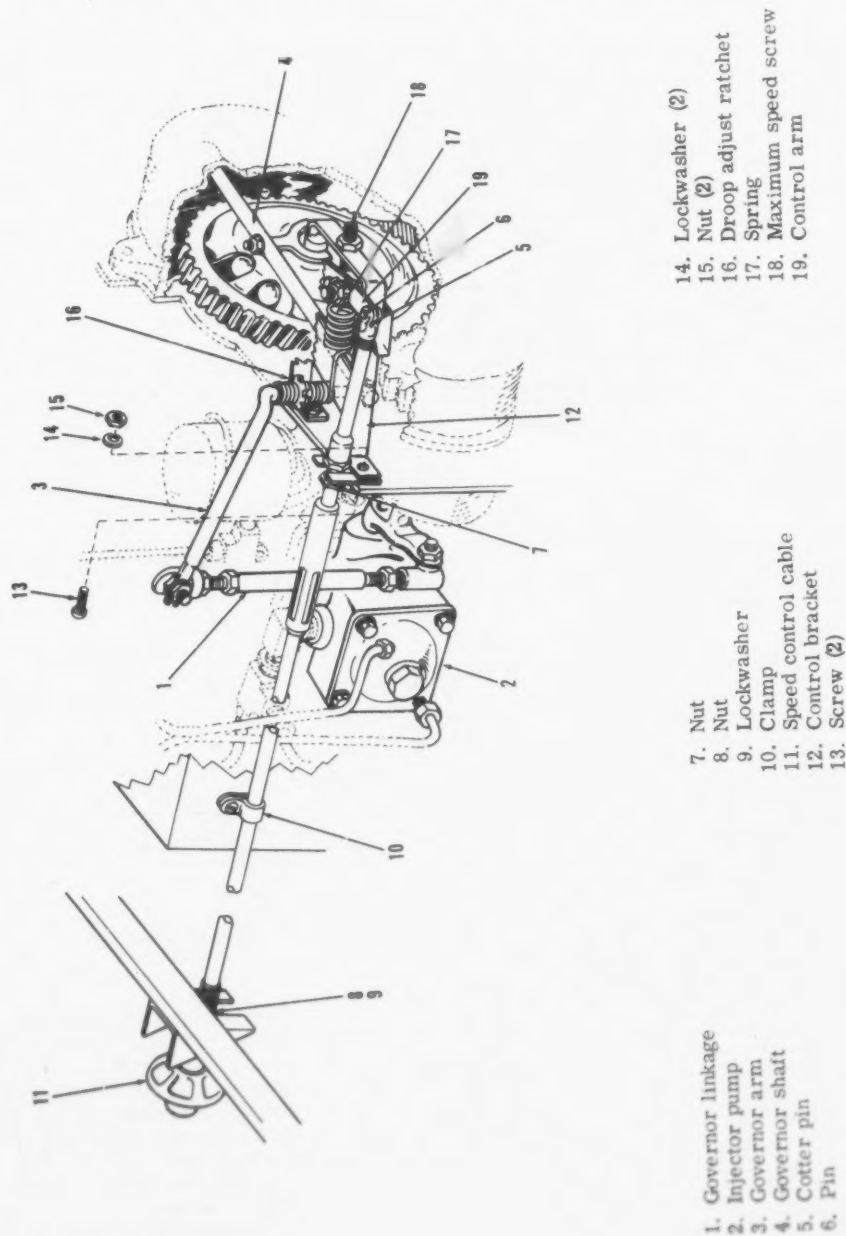


Figure T-1. Injector Fuel Lines



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Figure 7-2. Speed Control Assembly and Governor Control Assembly

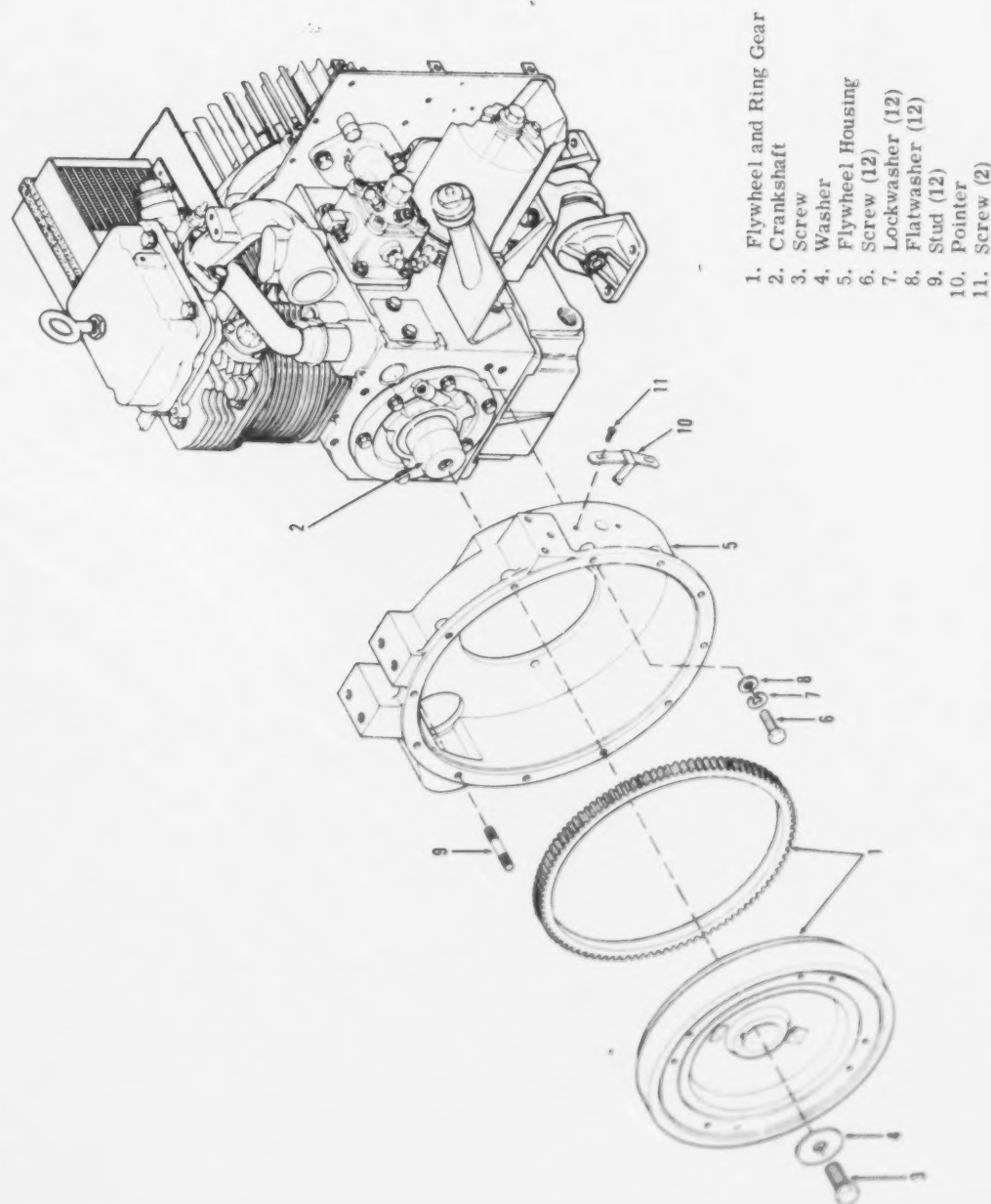


Figure 7-3. Engine Flywheel and Ring Gear Assembly

NOTE

As the piston comes up to Top Dead Center there is very little change in the dial indicator reading and extreme care should be used to establish the exact Top Dead Center.

e. Replace. Using screws (13, figure 7-2), lock-washers (14), and nuts (15), attach governor control bracket (12) to engine back plate. Attach speed control cable (11) to governor arm (3) with pin (6) and cotter pin (5). Attach governor arm (3) and governor linkage (1) between governor and fuel injection pump (2). If new ball joints are used on linkage, position the new joints to obtain the same length or 1/32 inch more (1 turn = 1/32 inch) than the old linkage. If old linkage length is not available, position new ball joints about midway on each end linkage, then lengthen 1/8 inch.

CAUTION

Do not overspeed engine for more than a moment.

Start engine and adjust speed control for 61.5 Hz output at no load. It should then be possible to move the entire linkage down 1/2 inch with a light finger pressure. If not, adjust linkage 1 turn at a time until 1/2 inch downward travel is obtained. It should then be possible to momentarily lift the linkage 1/2 inch with unit operating at rated load. Balance up and down travel by adjusting length of the linkage.

7-4. FLYWHEEL AND RING GEAR ASSEMBLY.

a. Removal (see figure 7-3).

(1) Remove engine from set per paragraph 2-9.

(2) Remove timing pointer (10, figure 7-3) by removing screws (11).

(3) The flywheel (1) is a tapered fit on the crankshaft (2). Remove flywheel mounting screw (3) and washer (4). Support and remove flywheel and ring gear assembly by using a two pronged wheel puller inserted through the slots provided in the flywheel.

b. Clean and Inspect. Clean the flywheel and ring gear assembly (1) using solvent. Check the ring gear for broken or worn teeth.

c. Install. Replacement flywheels are supplied with timing marks already stamped in place. The engine must still be timed properly to this timing mark. The only accurate method of determining the port closing point is to measure piston travel. This is a critical measurement and should be done only with accurate, dependable equipment. Mount flywheel keying properly and tighten in place using screw (3) and washer (4), (figure 7-3) With the flywheel mounted, rotate flywheel counterclockwise until Number 1 cylinder is on its compression stroke, which follows the closing of its intake valve. Remove the exhaust rocker arm (3, figure 10), exhaust valve rotator (1, figure 7-11), valve lock (2), spring retainer (3) and spring (8), using fabricated tool (see figure 7-10). Allow exhaust valve to drop down onto top of piston. Rotate flywheel counterclockwise until piston is at Top Dead Center. This can be measured on top of exhaust valve stem with a dial indicator (see figure 7-8).

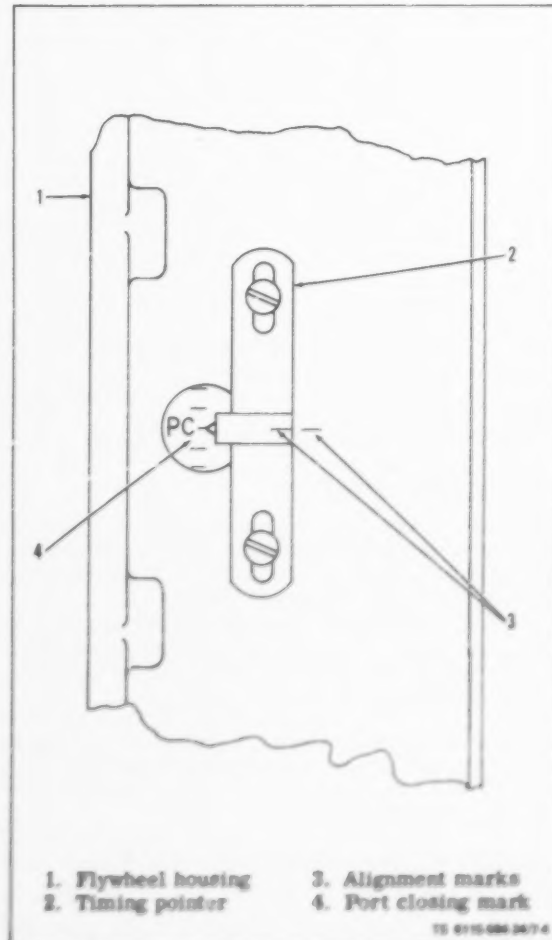


Figure 7-4. Timing Port and Port Closing Mark

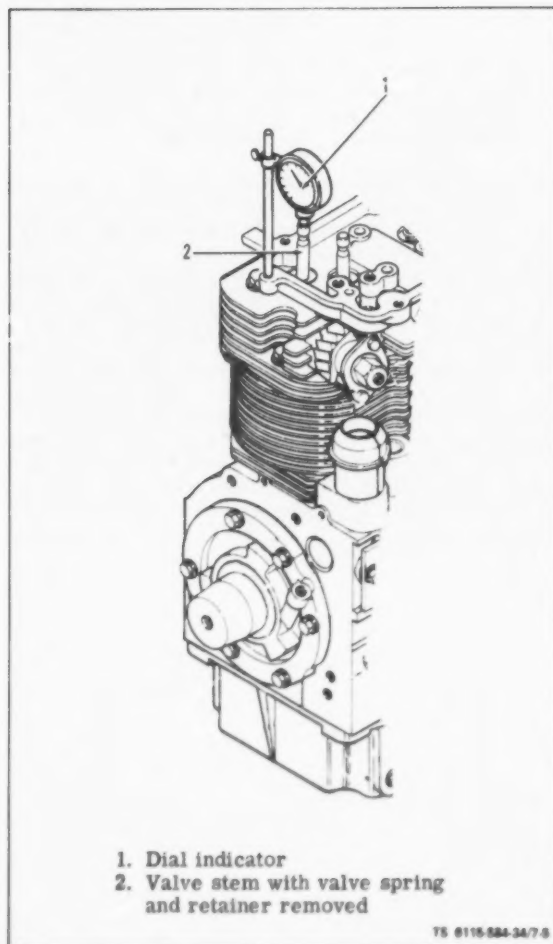


Figure 7-5. Measuring Top Dead Center

7-5. FLYWHEEL HOUSING.

a. Remove flywheel per paragraph 7-4. Remove flywheel housing (see figure 7-3). Remove screws (6), lockwashers (7) and washers (8) while supporting housing (5). Remove flywheel housing.

b. Clean and inspect. Inspect flywheel housing for cracks or dents. Wipe interior of housing with clean cloth. Check to see that pointer is not bent and securely mounted.

c. Install. Mount flywheel housing (5) to the engine using screws (6), lockwashers (7) and washers (8).

7-6. OIL COOLER.

a. Remove. Refer to Operator/Crew and Organizational Maintenance Manual and remove oil cooler.

b. Clean and inspect. In a suitable area clean oil cooler using a brush and fuel oil. Inspect for leaks, bent fins and/or bad inlet and outlet threads.

7-6

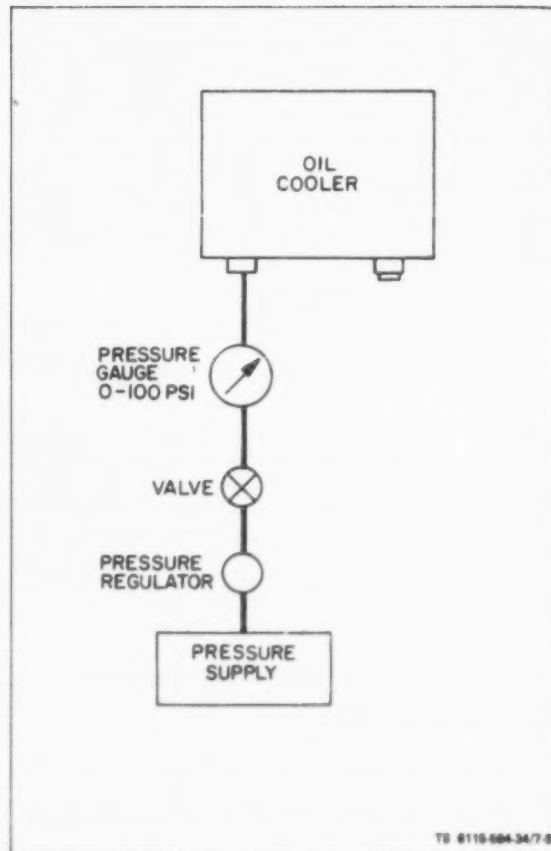


Figure 7-6. Testing Oil Cooler

c. Test (see figure 7-6).

(1) Plug the oil cooler outlet using suitable plug.

(2) Connect the oil cooler in suggested test set-up (see figure 7-6).

(3) Apply 25 psi air pressure to the oil cooler.

(4) Close the valve and monitor the pressure. A drop in air pressure indicates a leak in the oil cooler.

7-7. BLOWER WHEEL ASSEMBLY.

a. Inspect (see figure 7-7).

(1) Refer to Operator/Crew and Organizational Maintenance Manual and remove blower housing.

(2) Check blower wheel (4) for cracks or broken fins. Check for free play between blower wheel and hub. Replace torsion damper assemblies (5) if free play is present.

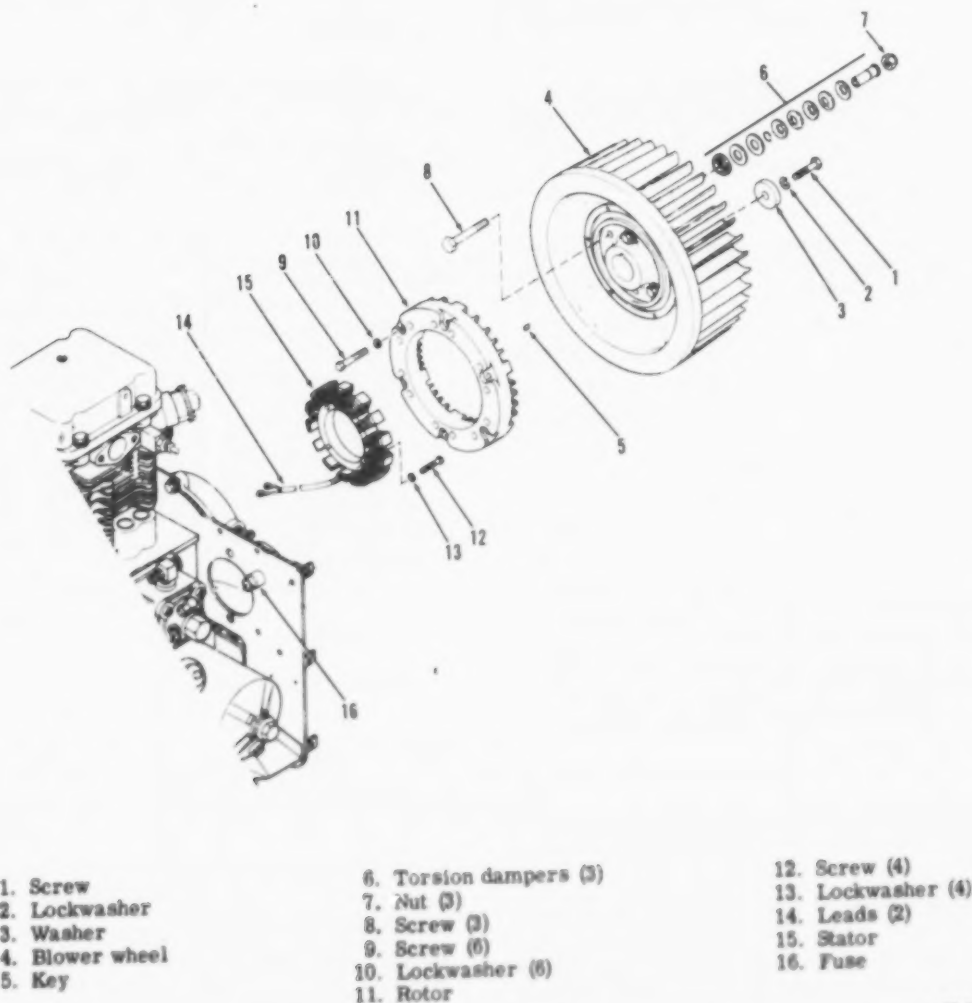


Figure 7-7. Battery Charge Alternator and Blower Wheel

b. Removal. Remove screw (1), lockwasher (2) and washer (3), attaching blower wheel to crankshaft. Use two 5/16-24 screws in blower hub and a suitable puller to remove blower wheel (4) and key (5).

NOTE

Observe the arrangement of the conical washers in the torsion dampers before disassembly. These washers must be reassembled in the same way or the function of the dampers will be impaired.

c. Repair. Blower wheel and hub are a balanced unit and should not be disassembled. To replace torsion damper assemblies (6), remove screws (8), nuts (7) and replace torsional dampers. Torque screws 25-30 ft-lb.

d. Install.

(1) Mount blower wheel assembly to crankshaft using screw (1), lockwasher (2) and washer (3). Torque screw (1) to 65-70 ft-lb.

(2) Refer to Operator and Organizational Maintenance Manual and install blower housing.

7-8. BATTERY CHARGE ALTERNATOR.

a. Inspect (see figure 7-7).

(1) Refer to Operator and Organizational Maintenance Manual and remove blower housing.

(2) Check stator wiring and voltage regulator wiring for loose connections or shorts. Check fuse F1 (16).

b. Test on Equipment.

(1) Load the batteries with a 12 ohm, 200 watt resistor (see figure 7-8). Run the set at 60 Hz, 1800 RPM. The charge rate should be between 6.5 and 10 amperes.

(2) With generator running (60 Hz), disconnect batteries leaving 12 ohm resistor load in circuit to generator. The alternator should provide a dc voltage between 24 and 28.5 volts.

c. Removal.

(1) Rotor. Refer to Operator and Organizational Maintenance Manual and remove the blower housing. Remove blower wheel assembly (4, figure 7-7) per paragraph 7-7. Remove rotor mounting screws (9) and lockwashers (10) attaching rotor (11) to blower wheel (4) and remove rotor (11).

(2) Stator. Disconnect stator leads (14, figure 7-7) from terminal block on engine back plate. Remove wire clamp from oil filter casting. Remove screws (12) and lockwashers (13) attaching stator (15) to engine and remove stator (15).

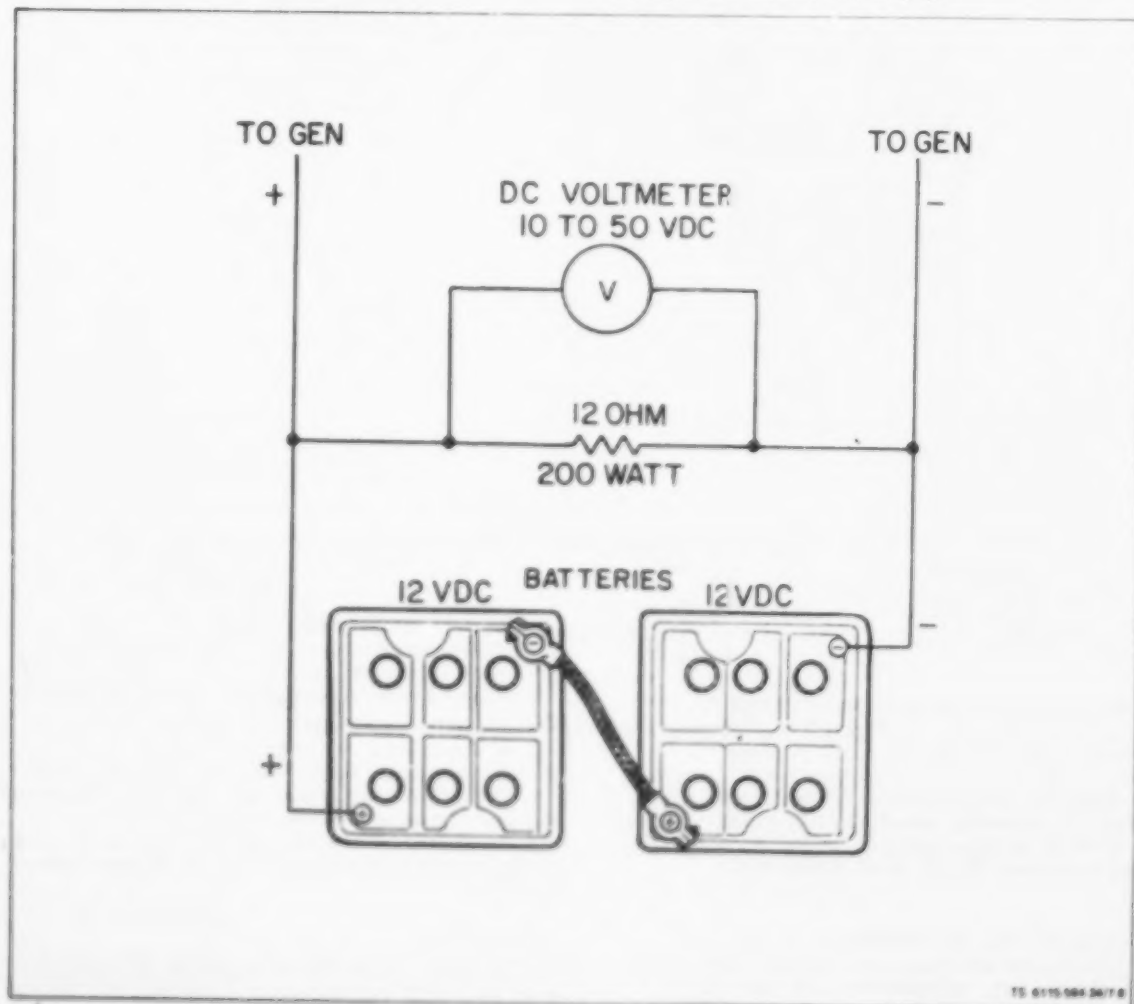


Figure 7-8. Resistively Loading the Batteries

d. Clean and Inspect. Clean blower wheel, stator and rotor with clean dry cloth. Inspect stator and rotor for signs of friction wear. Check stator wires for breaks, looseness and good insulation.

e. Test.

(1) Rotor. The rotor is a permanent magnet assembly and should not deteriorate.

(2) Stator. Using an ohmmeter, check the stator for open circuitry. High pot test the stator to ground for short circuits at 1070 volts.

f. Install.

(1) Stator. Attach stator (15) to engine using screws (12) and lockwashers (13). Replace wire clamp to oil filter casting. Reconnect stator leads (14) at terminal block.

(2) Rotor. Install rotor (11) into blower wheel (4) using screws (9) and lockwashers (10). Install blower wheel per paragraph 7-7. Install blower housing per Operator/Crew and Organizational Maintenance Manual.

Section III. ENGINE INTERNAL ASSEMBLIES

7-8.1. ENGINE COMPRESSION TEST.

The engine cylinder compression tests of this paragraph may be used to determine the condition of engine valves, pistons, piston rings, and cylinders. Normal cylinder pressure should be between 350 to 450 psi, depending upon engine condition. Corrective maintenance should be considered if cylinder pressure is below 325 psi or if there is a pressure difference of 15% or more between cylinders. These pressure ratings apply to a warm engine at cranking speed (approximately 300 rpm).

a. Compression Test.

(1) Run the engine until normal operating temperature is reached.

(2) Stop engine and remove all injector nozzle assemblies in accordance with paragraph 7-20a.

(3) Disconnect and tag wires to governor fuel shut off solenoid (K5).

(4) Obtain or fabricate two compression adapter mounting studs (see table 2-2).

(5) Install two compression adapter mounting studs (3, figure 7-8.1) into cylinder head (13) in place of screws (1, figure 7-45).

(6) Assemble gasket (7, figure 7-8.1), adapter (8), gasket (9), heat shield (10) and gasket (11) on compression adapter (6) (see table 2-1).

(7) Install compression adapter and assembled parts into cylinder head opening (12) of cylinder head (13).

(8) Install retainer flange (5) over compression adapter studs (3) secure compression adapter (6) to cylinder head (13) with two MS51967-2 nuts (2) (from bench stock) and washers (4).

(9) Connect compression tester gage (1) (see table 2-1) to compression adapter (6).

(10) Crank the engine. Read and record cylinder pressure as indicated by the compression tester gage.

(11) Remove nuts (2) from studs (3). Disassemble and remove items 4 through 11 from cylinder head (13).

CAUTION

Diesel engines have very close clearances. Too much oil squirted into the cylinder may cause a hydrostatic lock and damage the piston when the engine is cranked with compression adapter and tester gage installed.

(12) Squirt a small amount of oil (approximately 30 drops) into the cylinder through the cylinder injector opening (12).

(13) Assemble and reinstall items removed in step (11) above.

(14) Crank the engine. Read and record cylinder pressure. If the cylinder pressure has increased considerably from the pressure recorded in step (10) above, the rings and cylinder bore should be checked for correct tolerances and wear limits.

(15) If the cylinder pressure has increased only slightly, the mating surfaces of the valves should be checked for abnormal conditions.

(16) Repeat steps 5 through 15 for each cylinder.

(17) Install injector assemblies in accordance with paragraph 7-20i.

(18) Reconnect wires to governor fuel shut off solenoid (K5).

7-9. CYLINDER HEAD.

a. Removal (see figure 7-9).

(1) Remove. Refer to the Operator and Organizational Maintenance Manual and remove air shutter assembly and intake and exhaust manifold, muffler and shroud assembly. Remove engine lifting bracket, rocker cover and gasket, fuel nozzles, and connecting oil lines to cylinder head.

(2) Remove rocker arms by removing the self-locking rocker arm nuts (1, figure 7-9), rocker arm balls (2) on each rocker arm (3). Lift rocker arm (3) off.

(3) Remove capscrews (4) and push rod guide plate (5), screws (6) and washers (7) holding each cylinder head (8) to cylinder block (9).

(4) Remove push rod (15) and remove cylinder head. If head sticks, rap sharply with a soft hammer. Do not use a pry. Do not strike the cooling fins.

(5) Remove push rod shield (17) and packings (16), spring (18) and washers (19).

(6) Remove cylinder head gasket (20).

b. Disassembly (see figure 7-11).

(1) Remove valve rotator (1). Using a valve spring compressor (see figure 7-10), disassemble valve assemblies. Valve assemblies include spring retainer lock (2), (see figure 7-11), retainer (3), valve spring (5) and valves (8) and (10).

(2) Remove intake valve seals (4).

c. Clean and Inspect. Thoroughly clean all components of cylinder head assembly. Remove all carbon deposits from intake and exhaust ports and clean all

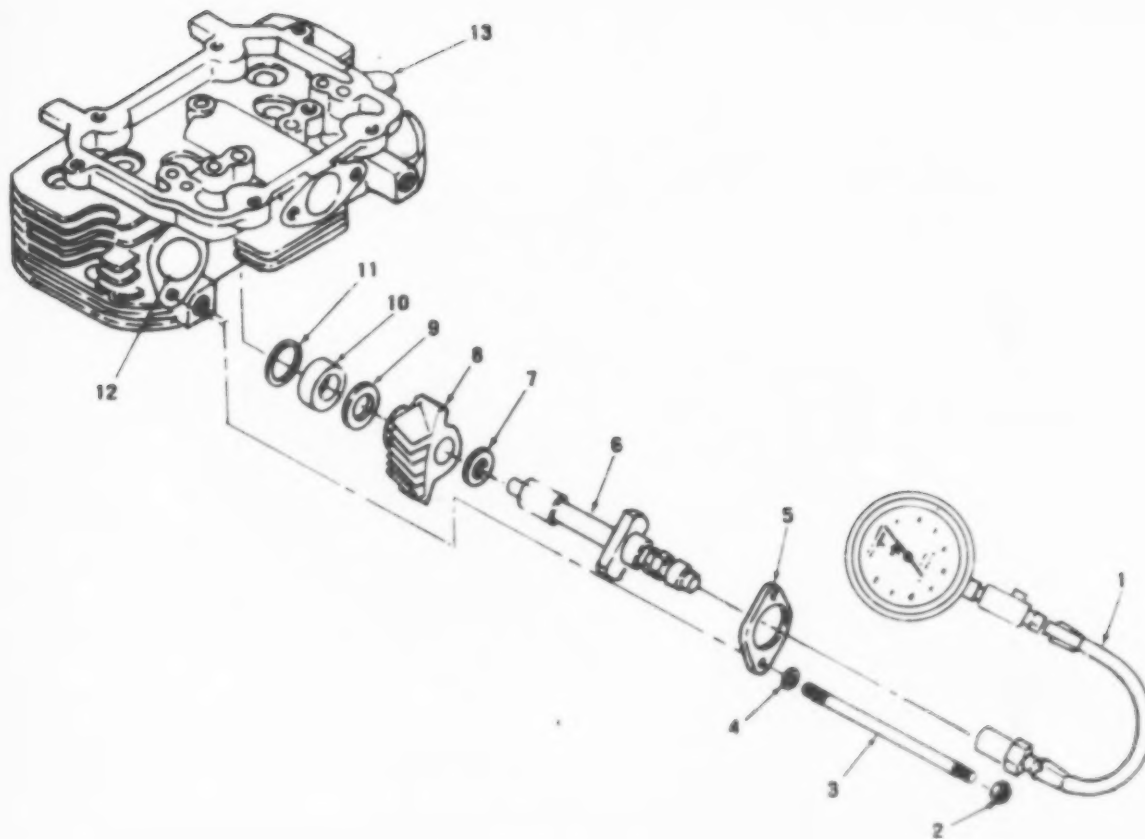
gasket surfaces. Inspect all cylinder head components for physical damage. Inspect cylinder head firing deck for warpage by measuring the maximum gap between the cylinder head and a steel straightedge placed in line and at a right angle to the cylinder head. If the gap exceeds the value in Table 1-2 in any direction, replace cylinder head.

d. Repair.

(1) Valves. Remove all carbon and check each valve (8 and 10, figure 7-11) for burning, pitting or warped head. Valves that are slightly pitted or burned, refinish on a valve grinder. Refinish intake valves to a 44° angle and exhaust valves to a 45° angle. But, if they are badly pitted, or will have a thin edge when refacing, replace them. Check refinished valves for a tight seat to the valve seat (7) with an air pressure type testing tool or by applying Prussian Blue on the valve face and rotating it against the seat.

(2) Valve Guides. Check valve guides (6 and 9, figure 7-11) to valve clearance. See table 1-2. If the proper clearance cannot be obtained by replacing valve, replace valve guides. Drive the old valve guides into valve chambers. Drive new intake guides (6) in until they protrude 11/32 inch from the rocker cover side of the head. Ream new valve guide to obtain the proper clearance. Exhaust guides (9) should protrude 5/8 inch from rocker cover side of the head.

(3) Valve Seats. If the valve seats (7, figure 7-11) are pitted, refinish them. Using seat grinding equipment, reface each seat to a value given in table 1-2. Seat width should be 3/64 to 1/16 inch for exhaust and 1/16 to 3/32 for intake. A seat can be refaced several times before it becomes necessary to replace it. If, however, the valve seats are loose or cannot be refaced, replace them. Adjust tool to cut 1/64 inch from edge of seat. Oil the pilot to prevent it from seizing in the valve guide. Cut each seat down to a narrow ridge on edges and bottom and break it out with a sharp tool.



- | | |
|---|--------------------------------|
| 1. Compressor tester gage | 8. Adapter |
| 2. Nut (2) | 9. Gasket |
| 3. Compression adapter mounting studs (2) | 10. Heat shield |
| 4. Washer (2) | 11. Gasket |
| 5. Retainer flange | 12. Cylinder injection opening |
| 6. Compression adapter | 13. Cylinder head |
| 7. Gasket | |

Figure 7-8.1. Testing Engine Compression.

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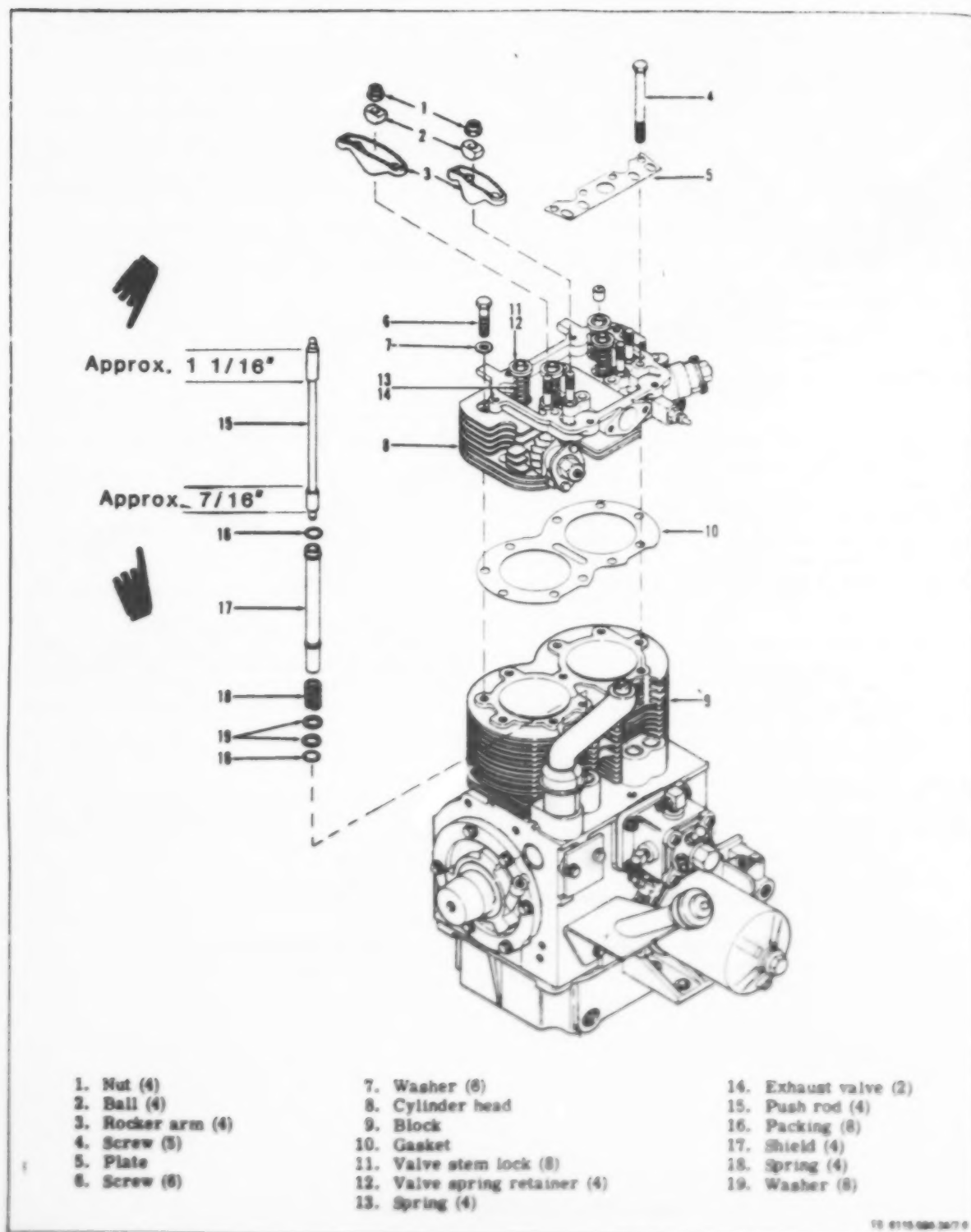
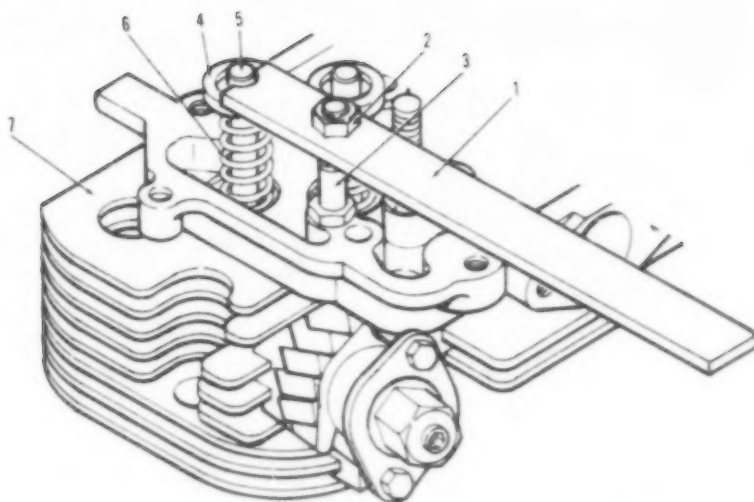


Figure 7-9. Cylinder Head Removal

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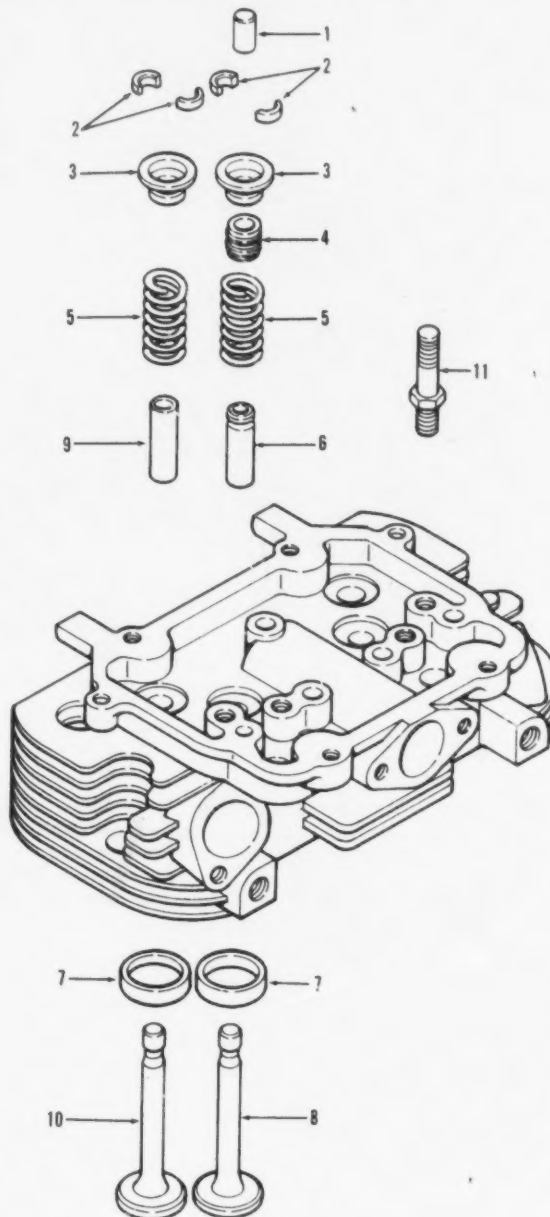
1. Valve spring compressor
2. Nut

3. Rocker arm stud
4. Valve spring retainer
5. Valve stem

6. Valve spring
7. Cylinder head

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Figure 7-10. Valve Spring Removal



- 1. Valve rotator (4)
- 2. Spring retainer lock (8)
- 3. Spring retainer (4)
- 4. Seal (2)

- 5. Valve spring (4)
- 6. Intake valve guide (2)
- 7. Valve seat (4)

- 8. Intake valve (2)
- 9. Exhaust valve guide (2)
- 10. Exhaust valve (2)
- 11. Rocker arm stud (4)

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Figure 7-11. Cylinder Head Assembly

Be careful not to cut into counterbore bottom. See figure 7-12. Thoroughly clean valve seat counterbore and remove any burrs from the edges. Drive new valve seat inserts into place. Be certain that each seat rests solidly on bottom of counterbore at all points. To make installation easier, heat cylinder head in an oven at 325° F (163°C) for about 1/2-hour. Face each new seat to the value given in table 1-2. The finished seat face should contact approximately center of the valve face. Use Prussian Blue on each valve face to check this. Make any corrections on the seat, not the valve face. When new seats are installed and faced, insert valve into each seat and check clearance from valve head to the face of cylinder head. If it is not the value given in table 1-2, regrind the seat.

(4) Valve Springs. Check valve springs (5, figure 7-11) on a compression scale. Valve spring data is given in the table 1-2. Replace any spring that is weak, cracked or pitted or has ends out of square.

(5) Push Rods. Check that push rod is absolutely straight. Replace bent or worn push rods.

e. Reassemble.

(1) Push a valve stem oil seal assembly (4) onto each intake valve guide (6, figure 7-11). Then oil inside surface of each seal.

(2) Oil the stem of each valve (8 and 10, figure 7-11) and insert each in its own guide (6 and 9). If intake valve (8) is removed with seal in place on guide, wrap sharp edge of valve notch with cellophane tape to protect seal bore.

(3) Check each valve for a tight seat.

(4) Using a valve spring compressor (see figure 7-10), compress each valve spring and insert the valve spring retainer (3, figure 7-11) and retainer locks (2). Install valve rotator (1).

f. Install (see figure 7-9).

(1) Place head assembly (8) and gasket (10) on cylinder block (9). Install springs (18), washers (19) and packings (16) on push rod shields (17) and install assembled push rod shields in cylinder block. Lift back side of cylinder head and place push rod shields in place, lower cylinder head in place. Use an anti-sieze compound on head bolt threads and thread bolts (4 and 6) and washer (7) into cylinder block (9).

CAUTION

Do not tighten head bolts at this time.

(2) Refer to Operator and Organizational Maintenance Manual and install intake manifold. Torque bolts 13-15 ft-lbs (see table 1-1). Bend over lock tabs. Now tighten head bolts 44 to 46 ft-lbs (see table 1-1) following the sequence in figure 7-13.

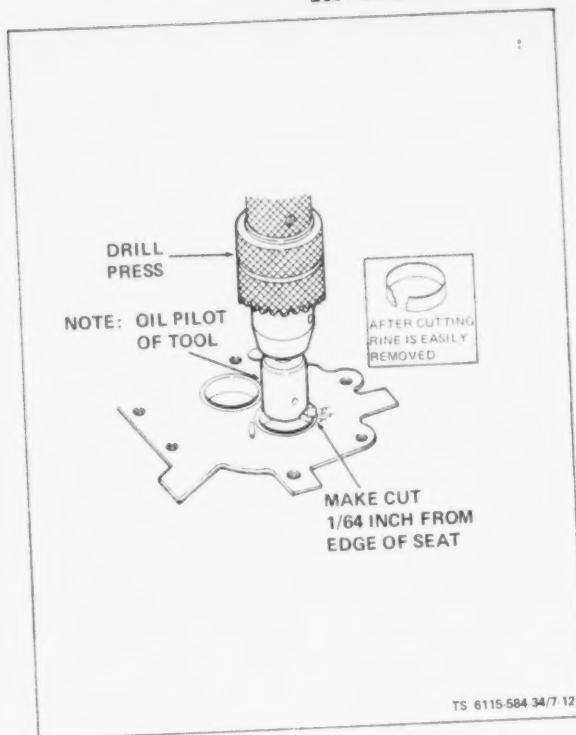


Figure 7-12. Valve Seat Replacement

(3) Refer to Operator and Organizational Maintenance Manual and install mufflers.

(4) Install push rods (15, figure 7-9), rocker arms (3), rocker arm balls (2) and rocker arm nuts (1).

(5) Set valve clearance per Operator and Organizational Maintenance Manual.

(6) Refer to Operator and Organizational Maintenance Manual and install air shutter assembly and shroud assembly.

NOTE

After the first 50-hours of operation, readjust valve clearance.

7-10. PISTON AND CONNECTING ROD.

a. General (see figure 7-14). Each piston (7) is fitted with three compression rings and an oil control ring (4). Full floating piston pins connect the piston to the connecting rod. The pins are held in place with a retaining ring (5) at each end. The lower end of each connecting rod contains half shell, precision bearings (11) and the upper end contains reamed bushings (13).

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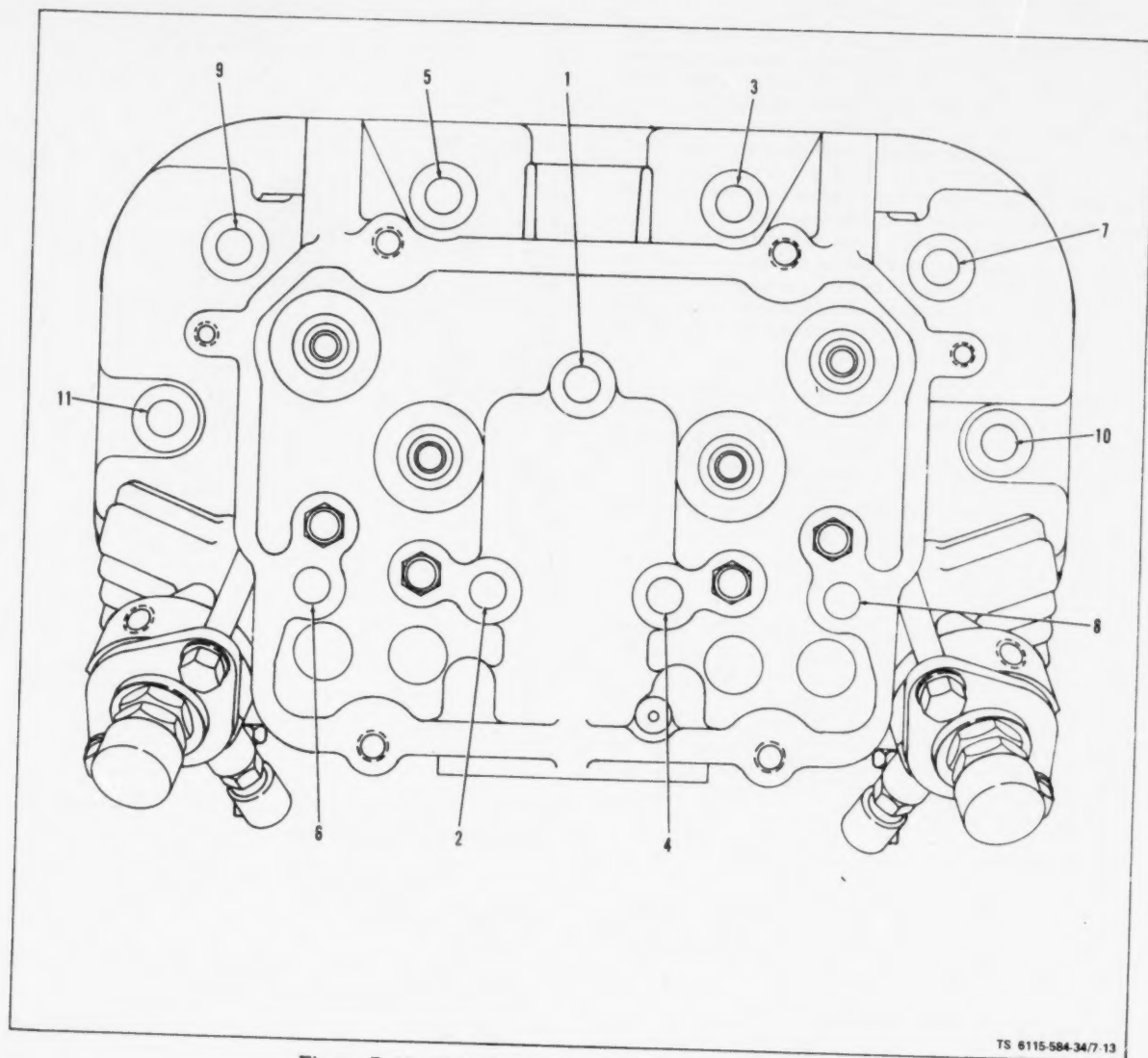
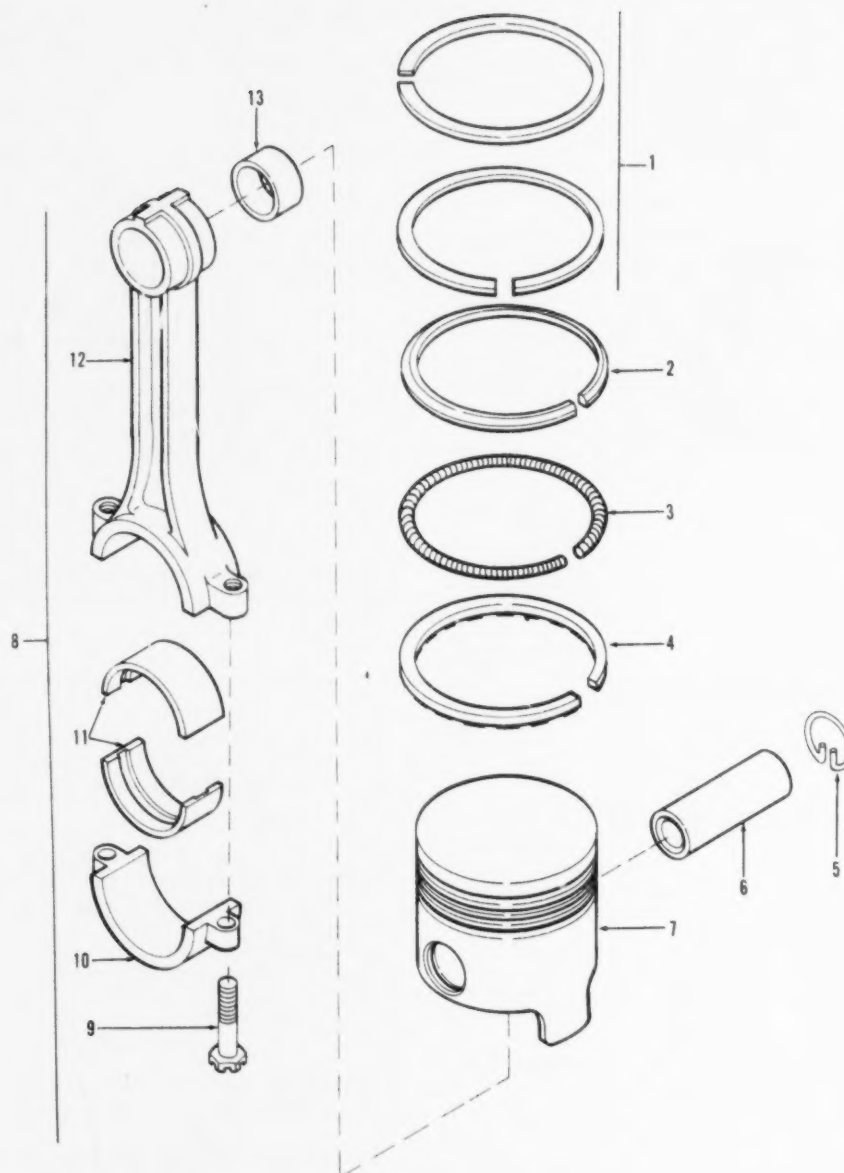


Figure 7-13. Cylinder Head Bolt Tightening Sequence

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- 1. Compression ring (plated) (2)
- 2. Compression ring
- 3. Oil ring expander
- 4. Oil ring

- 5. Retaining ring (2)
- 6. Piston pin
- 7. Piston
- 8. Connecting rod assembly
- 9. Bolt (2)

- 10. Cap
- 11. Bearing (2)
- 12. Connecting rod
- 13. Bushing (2)

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Figure 7-14. Piston and Connecting Rod

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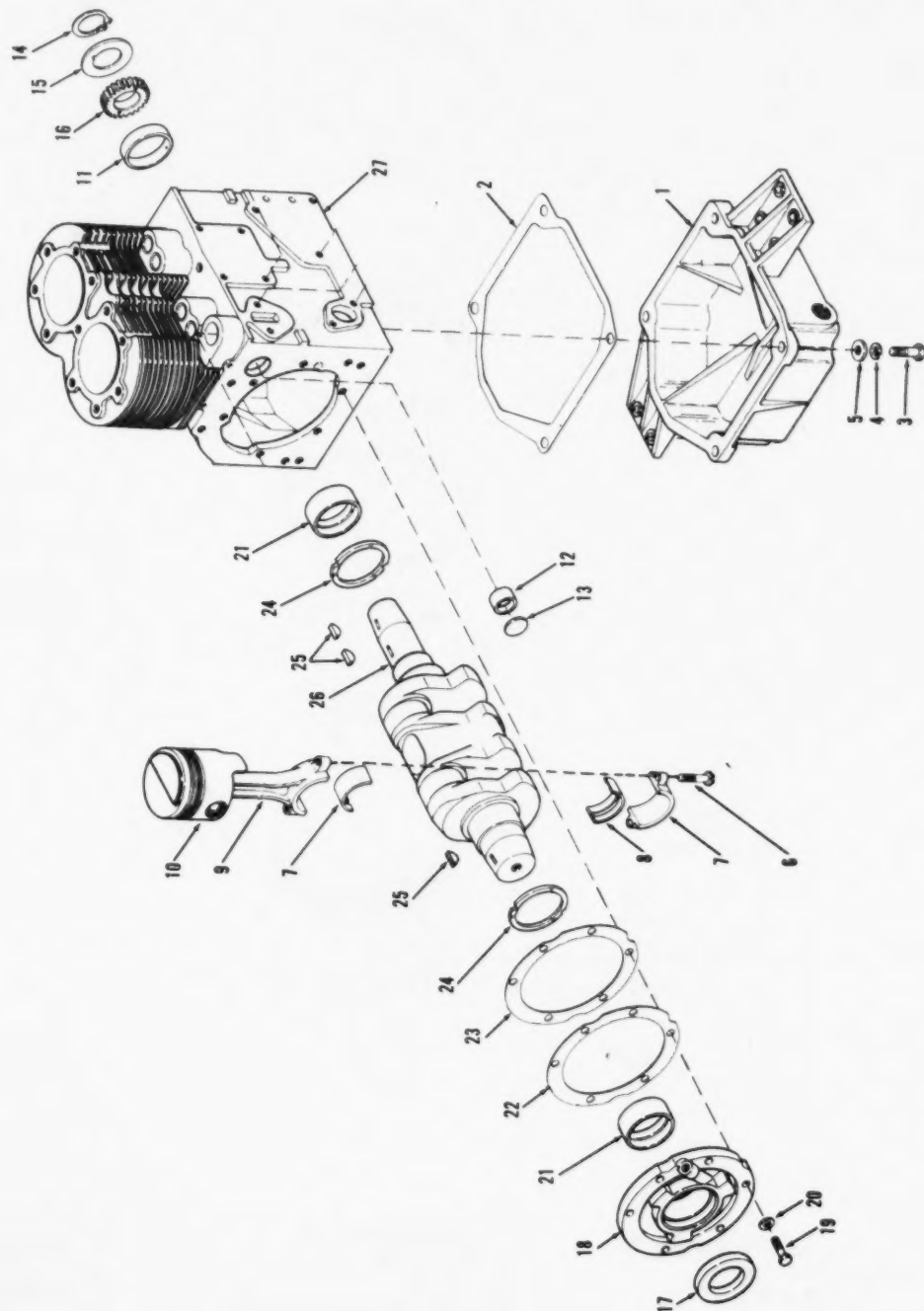


Figure 7-15. Crankshaft Pistons and Connecting Rod (Sheet 1 of 2)

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- | | | |
|-----------------------|----------------------------|--------------------------------|
| 1. Oil base | 10. Piston (2) | 19. Screw (6) |
| 2. Gasket | 11. Front camshaft bearing | 20. Lockwasher (6) |
| 3. Screw (4) | 12. Rear camshaft bearing | 21. Crankshaft end bearing (2) |
| 4. Lockwasher (4) | 13. Plug | 22. Gasket |
| 5. Washer (4) | 14. Retaining ring | 23. Shim |
| 6. Bolt (4) | 15. Crankshaft washer | 24. Thrust washer (2) |
| 7. Bearing (4) | 16. Crankshaft gear | 25. Keys (3) |
| 8. Cap (2) | 17. Packing | 26. Crankshaft |
| 9. Connecting rod (2) | 18. Rear bearing plate | 27. Cylinder block |

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Figure 7-15. Crankshaft Pistons and Connecting Rod (Sheet 2 of 2)

NOTE

The connecting rod and cap are stamped for installation in the proper cylinder. When removing piston assemblies, check the marking so each piston can be installed in the proper cylinder.

b. Removal (see figure 7-15).

(1) Drain crankcase oil and remove oil base (1) and gasket (2) by removing screw (3), lockwasher (4) and washer (5).

(2) Remove oil cup assembly (10, figure 7-19).

(3) Remove cylinder head (paragraph 7-9) and remove all carbon at the top of the cylinder bore. Remove ridge from cylinder bore before removing piston.

(4) Remove bolts (6, figure 7-15), cap (8) and bearings (7) from each connecting rod (9) and push the piston assembly (10) upward through top of cylinder bore with a soft wooden tool to prevent rod bearing damage. Loosely install cap (8) and bearings (7) on the corresponding removed piston assembly to maintain proper grouping.

c. Disassembly (see figure 7-14).

(1) Using a ring expander, remove piston rings (1, 2 and 4) and oil ring expander (3) from each piston.

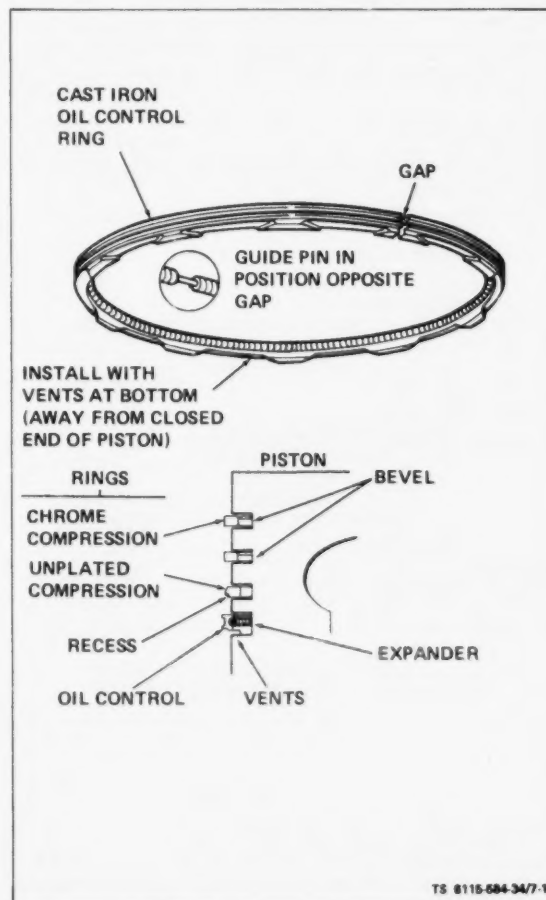
(2) Remove two retaining rings (5) and push piston pin (6) from each piston.

d. Inspect and Repair.

(1) **Pistons.** Thoroughly clean and inspect each piston. Clean carbon from ring grooves and be sure all oil holes are open. If any piston is badly scored or burred, loose in cylinders, has badly worn ring grooves or otherwise is not in good condition, replace it. Check the piston clearance in cylinder 90° from axis of piston pin and below oil control ring (4, figure

7-14). Clearance should be 0.0062 to 0.0082 inch (see table 1-2). If not, replace piston and check cylinder wall for possible reconditioning.

(2) **Piston Pins.** Each piston pin should be a thumb push fit into its piston at room temperatures.



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Figure 7-16. Piston Ring Installation

If pin is excessively loose, install a new piston and pin assembly.

NOTE

Piston and pins are matched sets and are not procured separately.

(3) Rings. Place each piston ring into its cylinder bore and using a feeler gauge measure gap dimensions. Gap is shown in Table 1-2. If gap is under 0.010 inch, file as follows:

(a) Place file in vise.

(b) Grasp piston ring in both hands.

(c) Insert file into ring gap and move ring down the entire length of file. Be sure to apply equal pressure on the ring.

(4) Connecting Rods (see figure 7-17). Clean connecting rods and check for each defects. Check connecting rod bushings for proper clearance with piston pin. Clearance is given in Table 1-2. If bushings (13, figure 7-14) are excessively worn, press them out and install one new bushing from each side of bushing bore. Press new bushings only until flush with sides of rod to leave 1/16 to 7/64 inch oil groove in center. Ream bushing I.D. to obtain the proper clearance. Check bore in connecting rod. Bore must be open. Check connecting rod alignment on a standard alignment fixture.

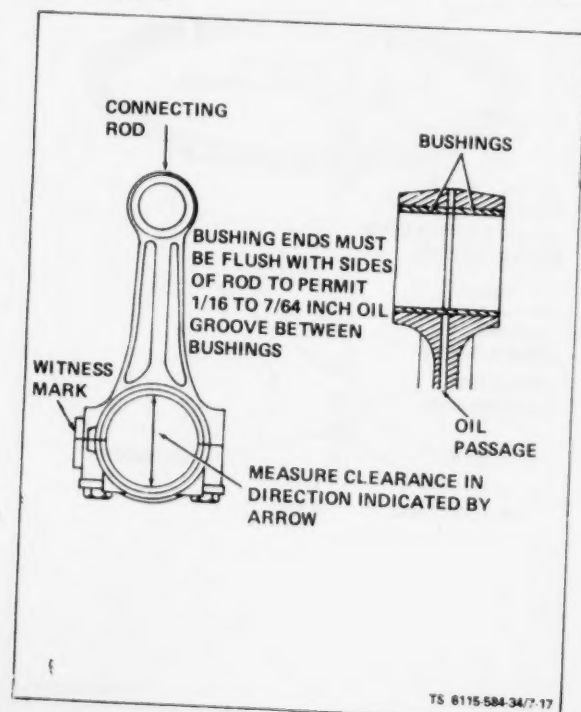


Figure 7-17. Connecting Rod and Bushings

(5) Connecting Rod Bearings (see figure 7-17). Inspect connecting rod bearings for burrs, breaks, pits and wear. Measure clearance between bearings and crankshaft journal. See Table 1-2 for clearance. If necessary, replace with new standard or undersize precision bearings.

e. Assembly (see figure 7-14).

NOTE

The piston witness mark (notch) must face front of engine and rod witness marks (numbers) must face toward camshaft side of engine.

(1) Install connecting rods (12, figure 7-14) on each piston (7) with pins (6) and retaining rings (5). If new bushings (13) were installed, check to see that ends are flush with the connecting rod (12) to provide for oil recess in the center.

(2) Install rings and oil ring expander (1, 2, 3 and 4) on each piston (7). Compression rings will be marked TOP or identified in some other manner. Place this mark toward the closed end of piston. Space ring gaps 1/4 of the way around piston from one another. No gap should be in line with piston pin. Oil the rings (1, 2 and 4) and pistons (7).

NOTE

When installing old bearings make sure they are installed in the same position they were removed from.

(3) Position a bearing half (11) in connecting rod (12) and cap (10). Be sure there is no dirt under bearing. This could cause high spots and early bearing failure.

f. Install.

(1) Hone cylinder walls. Clean and oil the cylinder walls. Install each piston in proper cylinder using a suitable installer. Each piston assembly should be installed with notch on piston toward front of engine. The notch on the circumference of the closed end of the piston should be located closest to front of engine.

(2) Position each connecting rod on crankshaft and oil the journal and install rod cap with bearing half. When installing rod cap, position so raised witness mark on the forging matches the mark on connecting rod. See figures 7-17 and 7-18. The piston witness mark should face front and rod witness marks toward camshaft side of engine.

(3) Tighten capscrews to specified torque. See table 1-1.

(4) Turn engine over by hand to see that all bearings are free.

NOTE

After installation of new connecting rod or main bearings, clearances should be checked using plastic gauge.

(5) Install oil base (1, figure 7-15) with a new gasket (2) using screws (3), lockwasher (4) and washer (5).

(6) Install cylinder head using proper bolt tightening sequence (see figure 7-13).

7-11. OIL PUMP.

a. Remove.

(1) Refer to paragraph 7-14 and remove gear cover.

(2) Refer to paragraph 7-10 and remove oil base assembly and oil cup assembly.

(3) Remove crankshaft gear lock ring (11, figure 7-19), gear (13) and retaining washer (12). At this time the crankshaft gear (13) should be inspected for signs of wear.

(4) Hold the pump (16) while removing attaching screws (14) and lockwashers (17). Remove pump.

b. Clean and Inspect.

(1) Inspect oil passages. Clean with stiff wire and wash out with fuel oil if necessary.

(2) Rotate pump drive gear and check that it rotates smoothly without binding.

c. Install (see figure 7-19).

(1) Install gear (16), retaining washer (15), and lockring (14).

(2) Fill pump intake and outlet with oil to be sure it is primed.

(3) Mount pump on engine using screws (14) and lockwashers (15). Allow pump drive gear to crankshaft gear clearance. Failure to allow clearance can damage oil pump.

(4) Install oil cup assembly (10) into pump.

(5) Install oil base (refer to paragraph 7-10).

(6) Install gear cover (refer to paragraph 7-14).

7-12. OIL FILTER ADAPTER ASSEMBLY.

a. Removal.

(1) Refer to the Operator/Crew and Organizational Maintenance Manual and remove the oil filter,

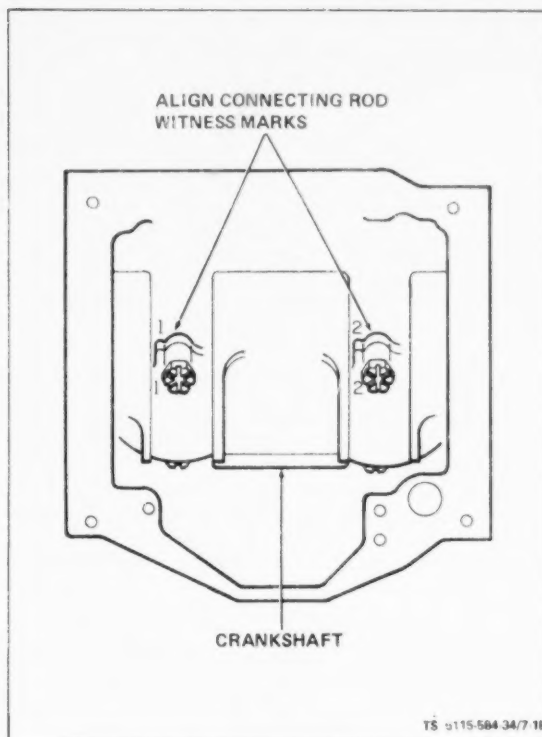


Figure 7-18. Connecting Rod Installation

oil pressure switch and oil lines connected to the oil filter adapter.

(2) Remove screws (20 and 21, figure 7-19) and lockwashers (22) and remove oil filter adapter (23) and gasket (24). Discard gasket.

b. Inspection. Clean and inspect oil filter adapter for damaged threads. Check oil passages for obstruction and clean if necessary.

c. Installation.

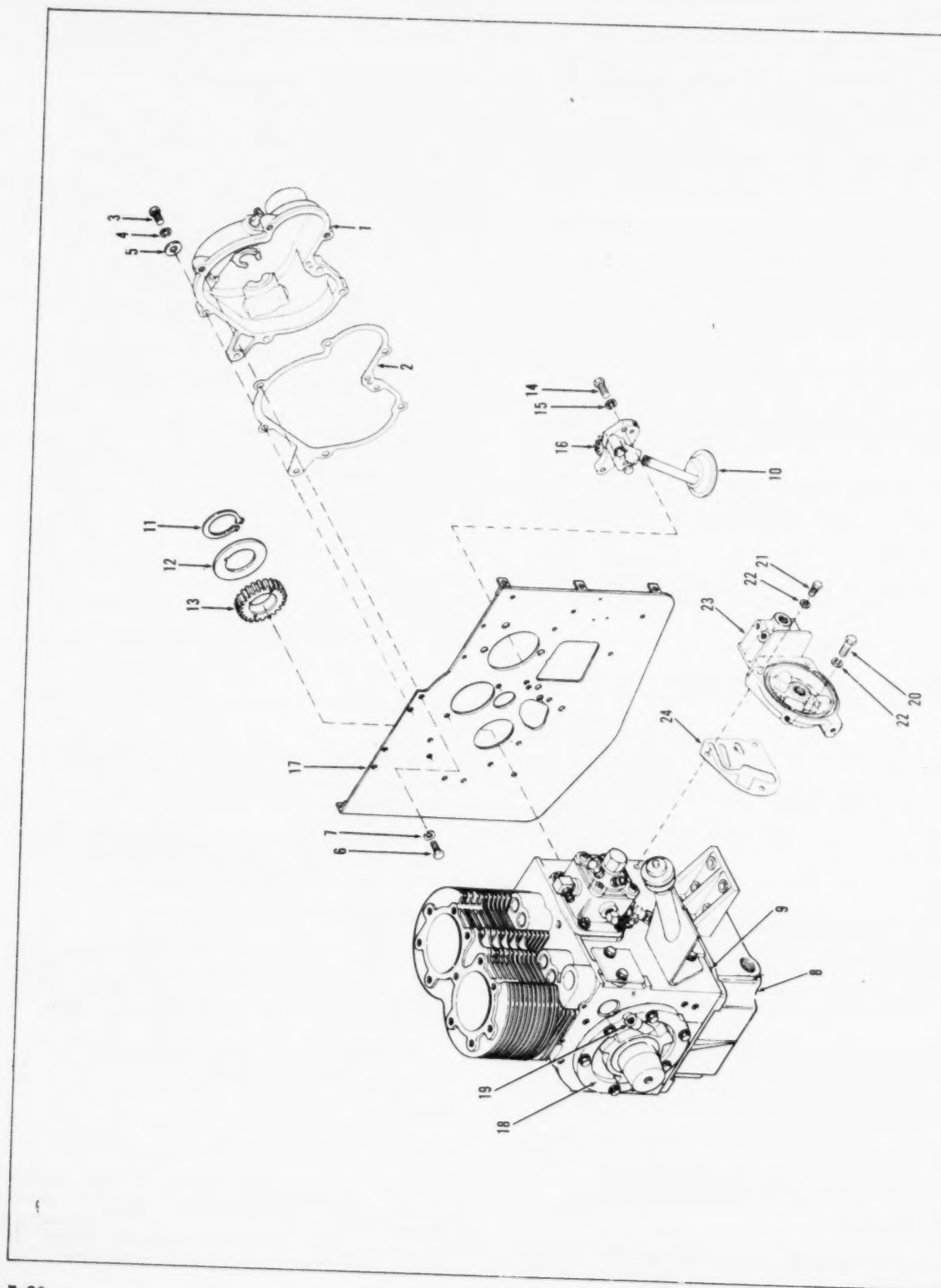
(1) Clean all gasket material from oil filter adapter (23, figure 7-19) and cylinder block. Attach oil filter adapter (23) and new gasket (24) to cylinder block with screws (20 and 21) and lockwashers (22).

(2) Refer to the Operator/Crew and Organizational Maintenance Manual and install the low oil pressure switch, oil filter and oil lines on the oil filter adapter.

7-13. OIL BY-PASS VALVE.

a. Test on Equipment (see figure 7-20). High oil pressure may be caused by the by-pass valve plunger sticking closed. Low oil pressure may be caused by the by-pass valve plunger sticking open. If these conditions exist, clean and inspect by-pass valve.

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Figure 7-19. Oil Pump Removal (Sheet 1 of 2)

- | | | |
|-------------------|----------------------|------------------------|
| 1. Gear cover | 9. Gasket | 17. Back plate |
| 2. Gasket | 10. Oil cup assembly | 18. Rear bearing plate |
| 3. Screw (4) | 11. Retaining ring | 19. Oil by-pass valve |
| 4. Lockwasher (4) | 12. Washer | 20. Screw (2) |
| 5. Washer (4) | 13. Crankshaft gear | 21. Screw (2) |
| 6. Screw | 14. Screw (2) | 22. Lockwasher (4) |
| 7. Lockwasher | 15. Lockwasher (2) | 23. Oil filter adapter |
| 8. Oil base | 16. Oil pump | 24. Gasket |

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Figure 7-19. Oil Pump Removal (Sheet 2 of 2)

b. Remove.

(1) Remove generator, engine flywheel, and adapter.

(2) Unscrew recessed plug (1, figure 7-20) in rear bearing plate (4).

(3) Lift out by-pass spring (2, figure 7-20) and valve plunger (3).

c. Cleaning and Inspection.

(1) Thoroughly clean spring (2, figure 7-20) and plunger (3). Replace defective or worn parts.

d. Test. Determine proper valve operation by checking spring and plunger against the following values.

(1) Plunger diameter should be 0.3365 inch to 0.3380 inch.

(2) Spring free length should be 2-5/16 inches $\pm$ 1/16 inch. Spring force should be 2.25 $\pm$ 0.11 pounds when spring is compressed to a length of 1-3/16 inches.

e. Installation.

(1) Assemble spring (2, figure 7-20) and plunger (3) and install in bearing plate (4).

(2) Install plug (1).

7-14. GEAR COVER ASSEMBLY.

a. Inspect (see figure 7-21).

(1) The governor shaft is supported by two sets of needle bearings and should not show signs of binding when rotated through its free travel.

(2) The oil seal should be inspected for leaks and damage.

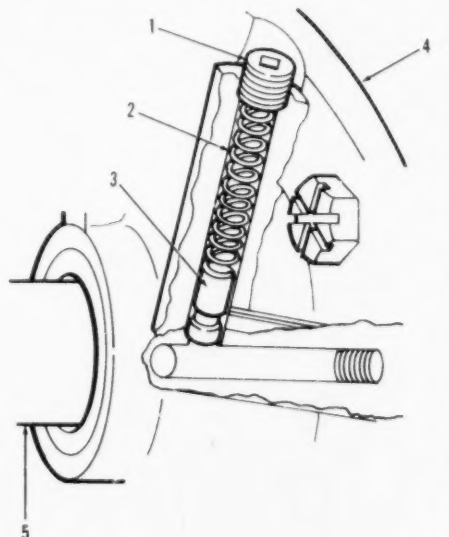
b. Removal.

(1) Refer to Operator and Organizational Maintenance Manual and remove starter lockout switch. Remove governor arm (3, figure 7-2) by loosening screw (3, figure 7-22).

(2) Refer to Operator and Organizational Maintenance Manual and remove blower housing.

(3) Refer to paragraphs 7-7 and 7-8 and remove blower wheel and stator.

(4) Remove screw from oil filter adapter. Remove screws (1, figure 7-21), lockwasher (2), flatwasher (3), screw (4), lockwasher (5) holding gear

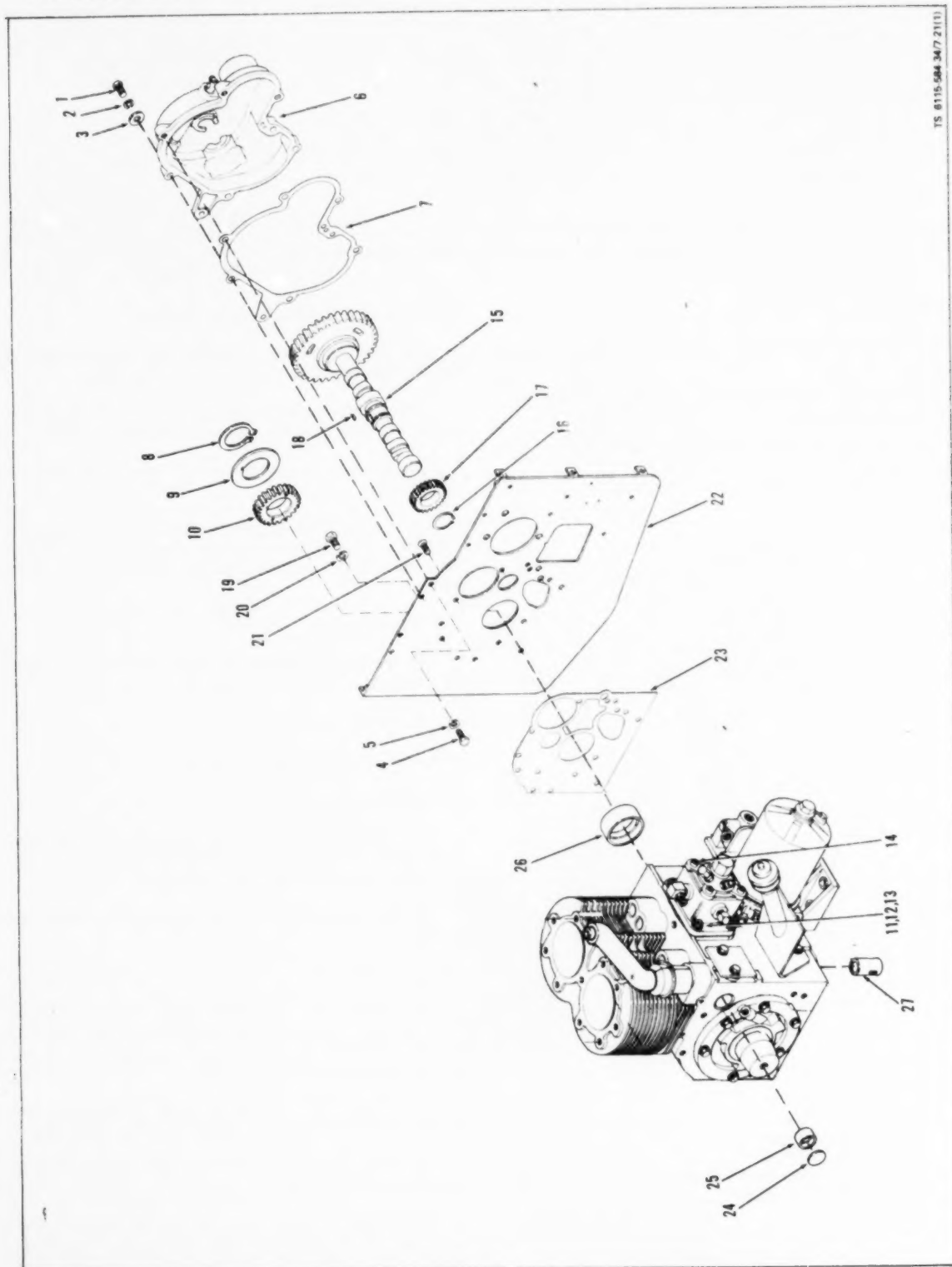


1. Plug
2. Spring
3. Valve
4. Rear bearing plate
5. Crankshaft

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Figure 7-20. Oil By-pass Valve

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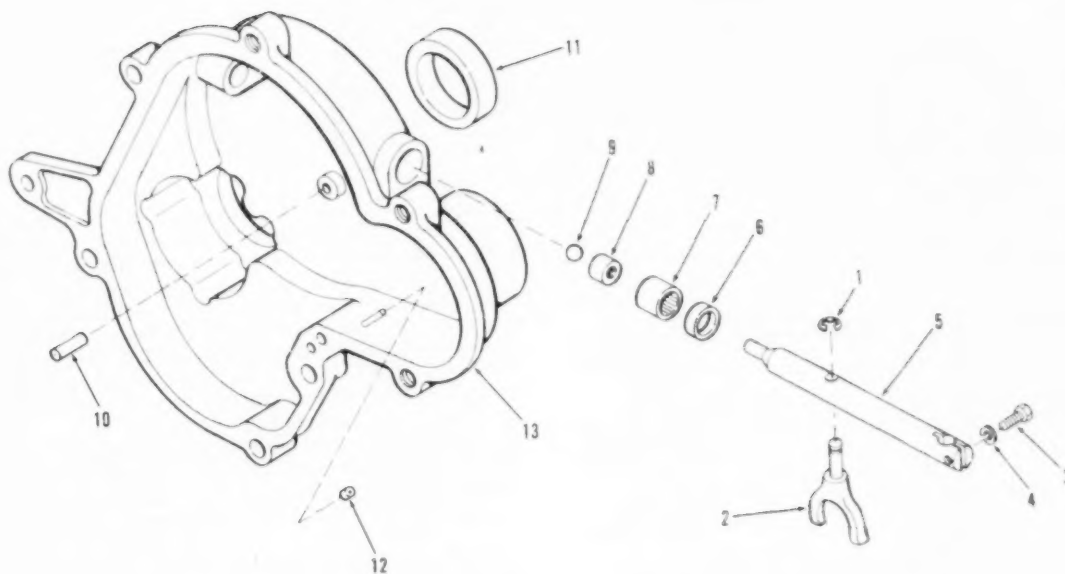
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Figure 7-21. Internal Engine Assembly (Sheet 1 of 2)

- | | |
|---------------------|----------------------------|
| 1. Screw (4) | 15. Camshaft assembly |
| 2. Lockwasher (4) | 16. Retaining ring |
| 3. Washer (4) | 17. Camshaft gear |
| 4. Screw | 18. Key |
| 5. Lockwasher | 19. Screw (3) |
| 6. Gear cover | 20. Lockwasher (3) |
| 7. Gasket | 21. Screw (2) |
| 8. Retaining ring | 22. Back plate |
| 9. Washer | 23. Gasket |
| 10. Crankshaft gear | 24. Plug |
| 11. Nut (4) | 25. Rear camshaft bearing |
| 12. Lockwasher (4) | 26. Front camshaft bearing |
| 13. Washer (4) | 27. Tappet (4) |
| 14. Injection pump | |

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Figure 7-21. Internal Engine Assembly (Sheet 2 of 2)



1. Retainer
2. Yoke
3. Screw
4. Washer

5. Governor shaft
6. Packing
7. Bearing
8. Bearing
9. Ball

10. Pin
11. Seal
12. Cup
13. Gear cover

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Figure 7-22. Gear Cover Components

cover (6) to crankcase. Tape crankshaft keyway to prevent damage to seal. To loosen gear cover, tap it with a soft hammer. Remove gasket (7).

c. Disassemble and Inspect.

(1) Governor Shaft (see figure 7-22). The governor shaft (5) is supported by two sets of needle bearings (7). To remove shaft, remove retainer (1) and yoke (2) and pull shaft (5) from gear cover (13). If shaft is binding, clean bearings, if loose, replace bearings. To remove larger bearing (7) drive bearing oil seal (11) out from the outside of gear cover. Remove smaller bearing (8) with bearing puller. Press new bearings and oil seal into place.

(2) Gear Cover Oil Seal (see figure 7-22). Replace oil seal if damaged or worn. Drive old seal (11) out from inside gear cover (13). Lay cover on a

board so seal boss is supported. Insert new seal from inside with rubber lip and closed case toward outside of gear cover and drive it flush with outside surface.

d. Reassemble.

(1) Work governor shaft to check for binding and see that governor-shaft-end-thrust ball is in place (see figure 7-23).

(2) Turn governor yoke so smooth side (convex surface) is toward governor cup (12, figure 7-22) on camshaft.

(3) Turn governor cup so the stop pin (figure 7-23) in the gear cover will fit into one of the holes in cup surface. Measure the distance from end of roll pin to mounting face of the cover. It should be 25/32 inch. If it is not, replace pin. Pin should be positioned with open end facing crankshaft seal.

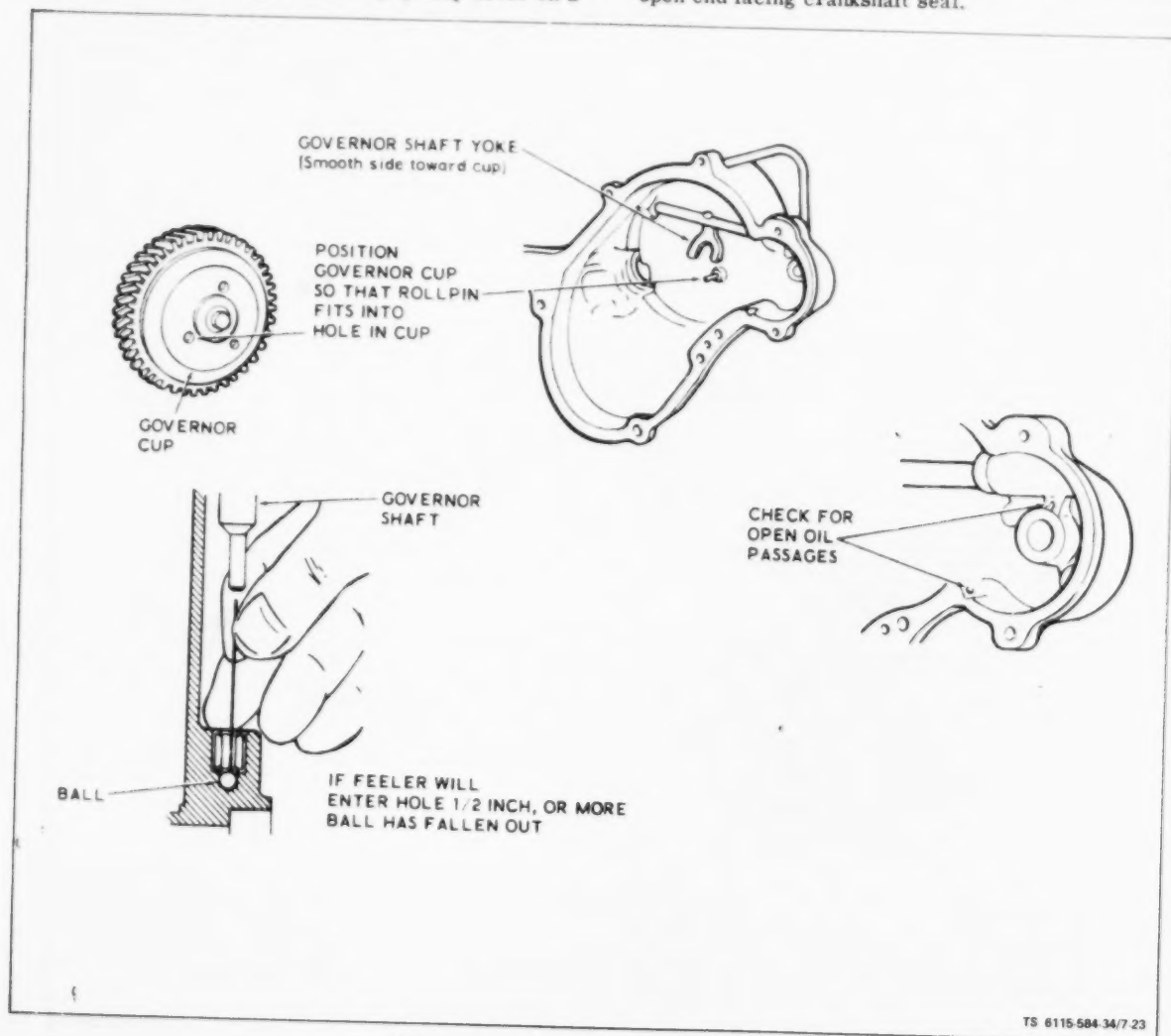


Figure 7-23. Gear Cover Inspection

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e. Install (see figure 7-21).

(1) Pack the cavity between the two oil seal lips with grease per MIL-G-23827.

(2) Tape keyway and sharp edges on crankshaft to protect the oil seal during installation.

(3) Mount gear cover (6) on engine using new gasket (7), screws (1 and 4), lockwashers (2 and 5), and flatwasher (3). Tighten mounting screws to specified torque. See table 1-1. Before tightening screws, be sure stop pin is in governor hole.

(4) Refer to Operator and Organizational Maintenance Manual and install starter lockout switch.

(5) Connect governor arm (3, figure 7-2) to governor shaft (5, figure 7-22) and tighten screw (3).

(6) Refer to paragraphs 7-7 and 7-8 and install stator and blower wheel.

(7) Refer to Operator and Organizational Maintenance Manual and install blower housing.

7-15. GOVERNOR CUP.

a. Remove (see figure 7-24). Remove retaining ring from camshaft center pin and slide cup off. Be sure to catch the ten flyballs that will fall out when cup is removed.

b. Repair. Replace any flyballs that have flat spots or grooves. Replace cup if race surface is grooved or rough. The governor cup must be a free spinning fit on camshaft center pin, but should be replaced if excessively loose or wobbly. Check distance the center pin extends from the camshaft gear, this distance must be $25/32$ inch to give proper travel distance for the cup (see figure 7-24). If it is less, the engine may race; if more, the cup will not hold the balls properly. If distance is too great, drive or press center pin in. If it is too small, replace pin; it cannot be removed without damaging the surface. If aluminum ball spacer openings are badly worn, replace ball spacer. (Camshaft must be removed for this.)

c. Install. To install governor assembly, fill flyball recesses with grease MIL-G-23827 and install flyballs. Position governor cup on shaft and install retaining ring.

7-16. CAMSHAFT ASSEMBLY AND TAPPETS.

a. Removal.

(1) Refer to Operator and Organizational Maintenance Manual and remove blower housing.

(2) Refer to paragraph 2-9 and remove engine.

(3) Refer to Operator and Organizational Maintenance Manual and remove rocker arm covers.

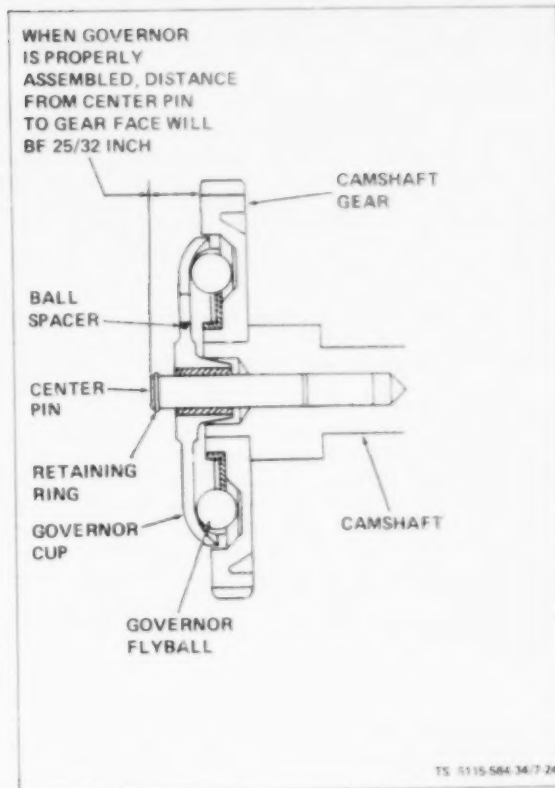


Figure 7-24. Governor Cup Assembly

(4) Refer to paragraph 7-14 and remove gear cover.

(5) Refer to paragraph 7-18 and remove fuel injection pump.

(6) Remove crankshaft gear retaining washer (9, figure 7-21) by removing lock ring (8) on the crankshaft.

(7) Refer to paragraph 7-9 and remove rocker arms and push rods.

(8) Refer to paragraph 7-10 and remove oil base.

(9) Lay engine on side to avoid dropping tappets (27) and remove camshaft assembly (15) as a group. If necessary, pry it out with a screwdriver between camshaft gear and crankcase. Remove retaining ring (16) and press gear (17) off camshaft.

(10) Remove the valve tappets (27). These can be removed only from bottom of crankcase.

(11) Refer to paragraph 7-17 and remove crankshaft gear.

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(12) Remove back plate (22) and gasket (23) by removing screws (19), screws (21) and lockwashers (20).

(13) Camshaft Bearings. The camshaft bearings (25 and 26, figure 7-21) should be replaced if clearance to camshaft is greater than specified in table 1-2, bearings show cracks, breaks, burrs, excessive wear, or other defects. The camshaft to bearing clearance should be 0.0012 to 0.0037 inch (see table 1-2). To check rear bearing (25) remove expansion plug (24) at rear of crankcase.

b. Cleaning and Inspection. If a cam lobe has become slightly scored, dress it smooth with a fine stone. If camshaft is badly worn or scored, replace it.

c. Installation.

(1) Press new camshaft bearings into place. See figure 7-25 for proper placement. Press rear bearing flush with bottom of expansion plug recess. Press front bearing in flush with crankcase front surface so oil passages are aligned. Do not attempt to rear bearings, they are a precision type. After rear bearing is installed, insert a new expansion plug in recess, using sealing compound, and expand it into place with sharp blows at its center.

NOTE

Expansion plug must not protrude from rear face of crankcase.

(2) Install new gasket (23, figure 7-21) and back plate (22) with screws (19 and 21) and lockwashers (20).

(3) Refer to paragraph 7-17 and install crankshaft gear.

(4) With engine laid on its side, install tappets (27, figure 7-21).

(5) Install key (18, figure 7-21) on camshaft (15), press on gear (17) and install retaining ring (16).

(6) Install camshaft assembly (15) in engine making sure tappets (27) are in place on push rods. Align timing marks on camshaft gear and crankshaft gear (see figure 7-26). Check gear lash (see figure 7-27).

(7) Install oil base per paragraph 7-10.

(8) Install crankshaft gear retaining washer (9, figure 7-21) and retaining ring (8) on the crankshaft.

(9) Refer to paragraph 7-9 and install rocker arms.

(10) Refer to paragraph 7-18 and install fuel injection pump.

(11) Refer to paragraph 7-14 and install gear cover.

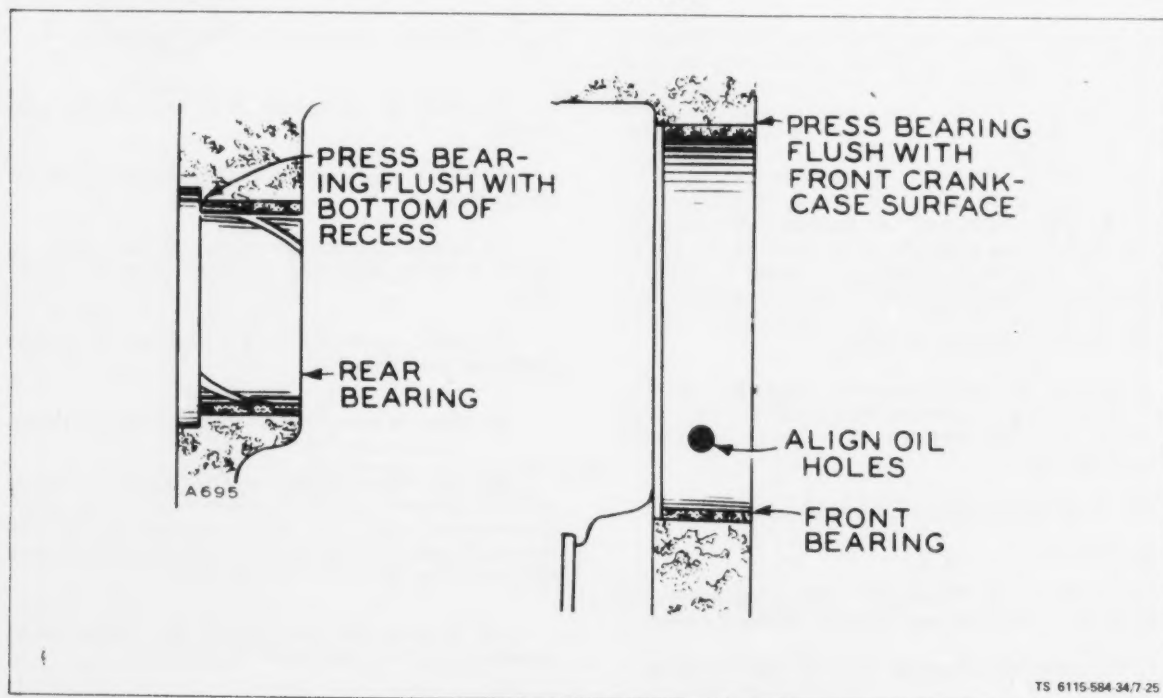


Figure 7-25. Camshaft Bearing Installation

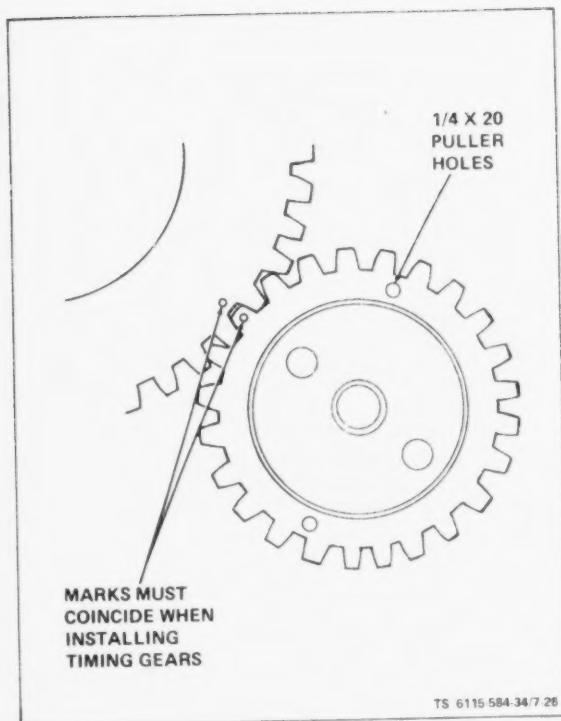


Figure 7-26. Crankshaft and Camshaft Gear Timing Marks

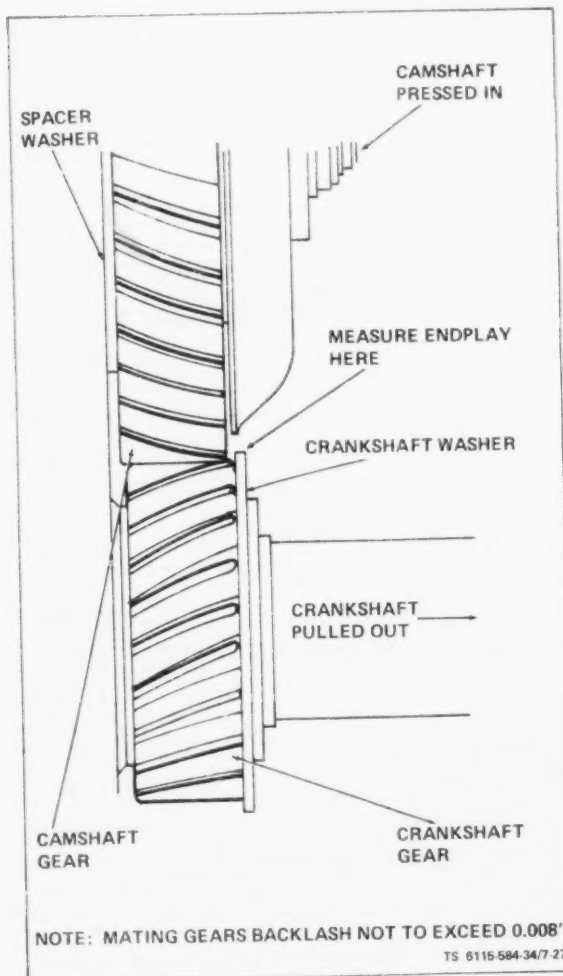


Figure 7-27. Timing Gear Backlash

(12) Refer to Operator and Organizational Maintenance Manual and install rocker arm covers.

(13) Refer to paragraph 2-9 and install engine.

(14) Refer to Operator and Organizational Maintenance Manual and install blower housing.

7-17. CRANKSHAFT AND BEARINGS.

a. Removal (see figure 7-15).

(1) Refer to Operator and Organizational Maintenance Manual and remove blower housing.

(2) Refer to paragraph 2-9 and remove engine.

(3) Refer to paragraph 7-7 and remove blower wheel.

(4) Refer to paragraph 7-8 and remove alternator stator.

(5) Refer to paragraph 7-14 and remove gear cover.

(6) Refer to paragraph 7-9 and remove cylinder heads.

(7) Refer to paragraph 7-4 and 7-5 and remove flywheel and housing.

(8) Refer to paragraph 7-10 and remove oil base.

(9) Refer to paragraph 7-11 and remove oil pump cup assembly.

(10) Remove lock ring (14) and retaining washer (15) in front of crankshaft gear (16).

(11) Pull off crankshaft gear. It has 2-1/4-20 UNC tapped holes for attaching a gear pulling ring (see figure 7-28). Use care not to damage teeth if gear is to be re-used. Remove woodruff keys (25, figure 7-15).

(12) Refer to paragraph 7-10 and remove connecting rod and piston assemblies.

(13) Remove rear bearing plate (18, figure 7-15) from crankcase. Remove gasket (22) and shims (23).

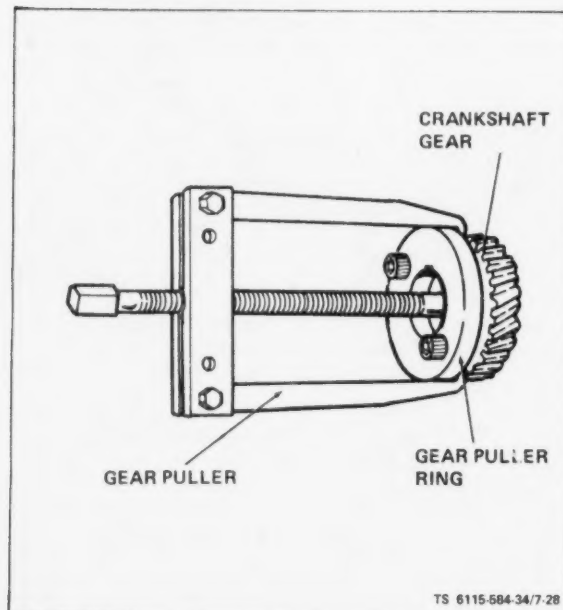


Figure 7-28. Crankshaft Gear Removal

(14) Remove crankshaft (26) through rear opening in crankcase.

b. Clean and Inspect.

(1) Crankshaft. Clean crankshaft and blow out all oil passages. Check journals for out-of-round, taper, grooving or ridges. Pay particular attention to ridges or grooves on either side of oil hole areas. Unusual conditions here often point to previous neglect of oil changes. If journal dimensions are not within limits or journals are scored, metallize and regrind crankshaft to standards.

(2) Bearings. Replace bearings if clearances are greater than limits (see table 1-2), or if bearings are worn, grooved or broken.

(3) Rear Oil Seal. Inspect seal for wear or damage which might cause it to leak.

c. Rebuild Crankshaft. If crankshaft requires re-grinding, metallize and regrind to standards. Special procedures must be observed when reworking diesel crankshafts. In addition to regrinding, the crankshaft must be shot-peened and super-finished. Failure to shot-peen the crankpin fillets is likely to cause early failure. When the shaft is reground, follow this data and figure 7-29 to shot-peen each crankpin fillet.

- (1) Almen gauge reading, 0.012-A.
- (2) Peen with 0.019 inch diameter cast steel shot.
- (3) Peen for 30-seconds on each crankpin fillet.

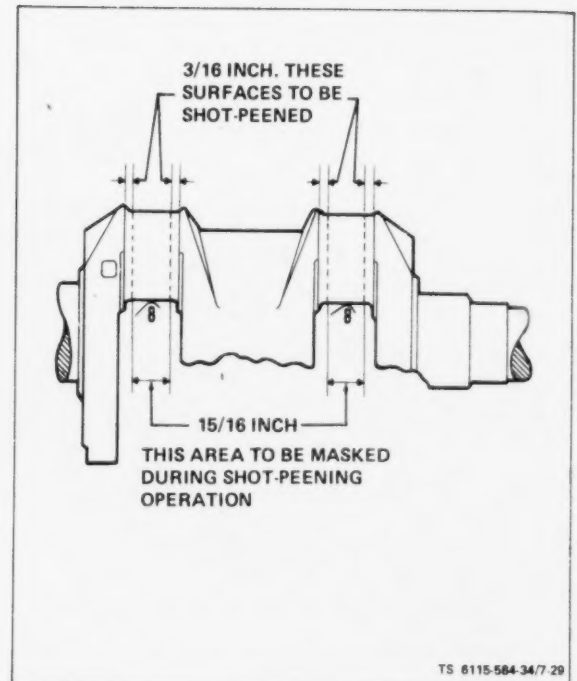


Figure 7-29. Crankshaft Peening

(4) Mask off connecting rod bearing areas.

d. Installation.

NOTE

After each installation step, check crankshaft to be sure it is not frozen in place.

(1) Heat cylinder block (27, figure 7-15) and bearing plate (18) at 325° F (163° C) in an oven 30 minutes and press front and rear main bearings (21) into place, aligning bearing housing oil holes (see figure 7-30).

(2) Install thrust washers (24, figure 7-15) on locking pins (see figure 7-30).

(3) Oil bearing surfaces and install crankshaft (26, figure 7-15) from rear of crankcase, through rear bearing plate hole.

(4) Place gasket (22) on each side of shim (23).

(5) Before installing bearing plate, tape keyway and sharp edges on crankshaft to protect the oil seal during installation. Mount and secure rear bearing plate (18).

(6) Check crankshaft end play (see figure 7-31). Use enough rear bearing plate shims to provide 0.010

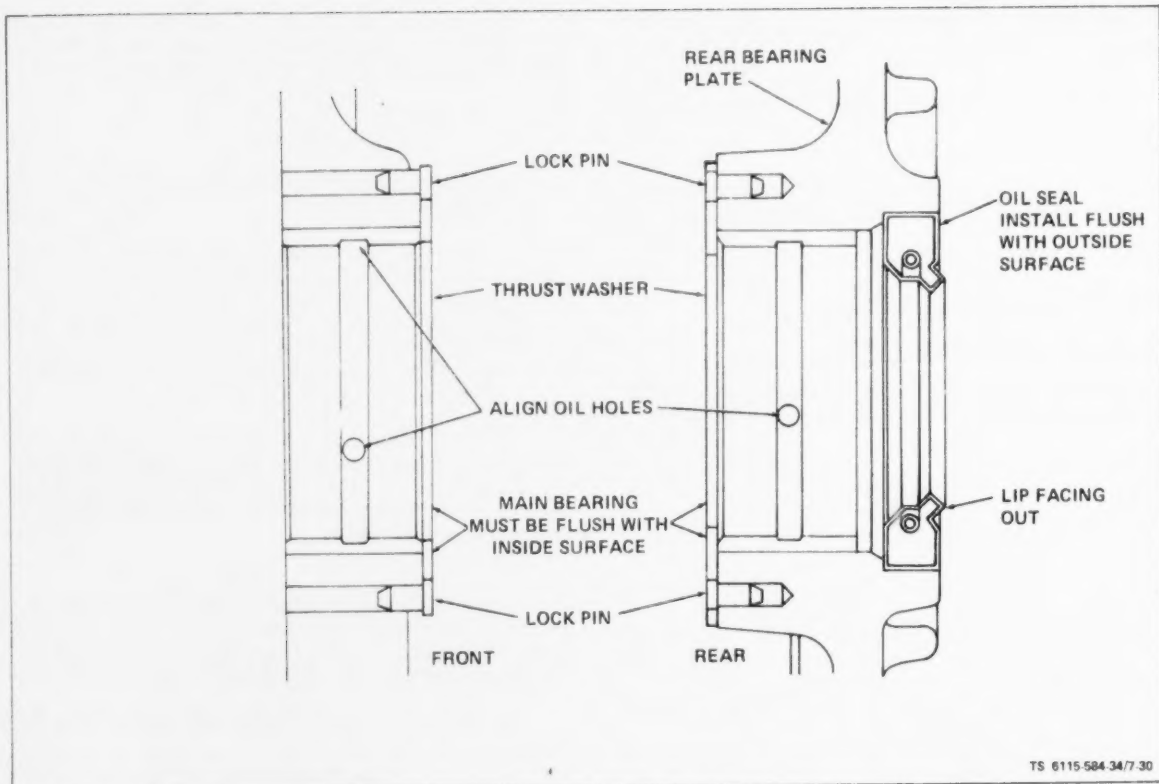


Figure 7-30. Crankshaft Bearing Installation

to 0.015 inch end play. If more than 0.010 inch total thickness is required, then use a steel shim of proper thickness and an 0.005 inch thick gasket on each side of shim. This avoids excessive gasket compression and maintains bolt torque. Shims are available in 0.005, 0.010, 0.015, and 0.020 thickness.

(7) Install keys (25) on crankshaft (26), then drive gear (16) into place using fabricated tool (see table 2-2). Install retaining washer (15) and lock ring (14).

(8) Refer to paragraph 7-10 and install rod and piston assemblies.

(9) Refer to paragraph 7-5 and install flywheel and housing.

(10) Refer to paragraph 7-4 and 7-5 and install flywheel and housing.

(11) Refer to paragraph 7-11 and install oil base.

(12) Refer to paragraph 7-14 and install gear cover.

(13) Refer to paragraph 7-8 and install alternator stator.

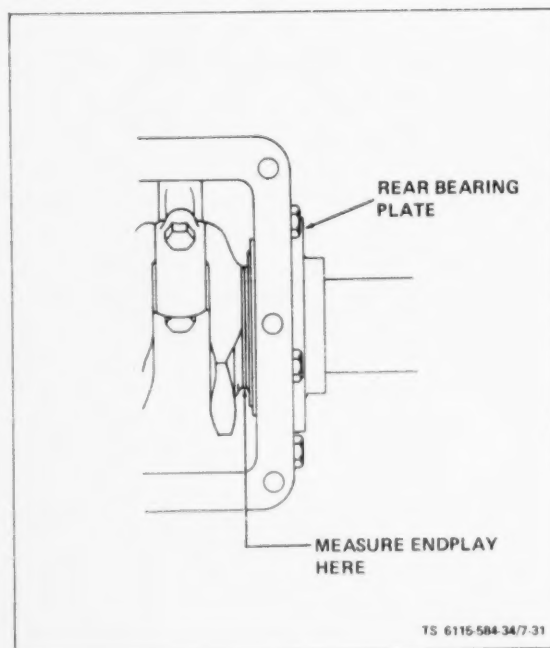


Figure 7-31. Crankshaft End Play Measurement

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(14) Refer to paragraph 7-7 and install blower wheel.

(15) Refer to paragraph 7-9 and install cylinder heads.

(16) Refer to Operator and Organizational Maintenance Manual and install blower housing.

7-18. FUEL INJECTION PUMP.

a. Removal (see figure 7-32).

(1) Snap off governor linkage from injection pump (1), and governor control arm and remove linkage.

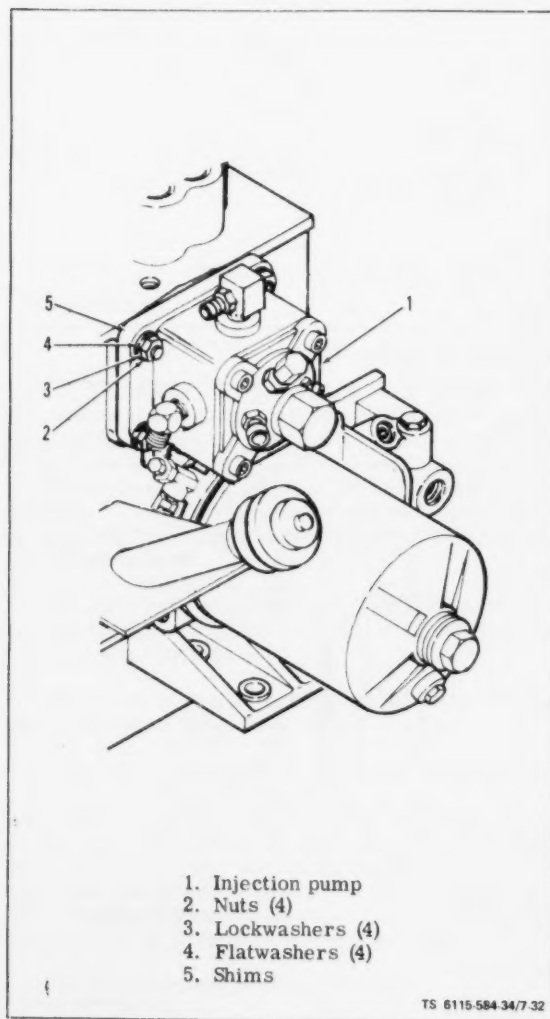


Figure 7-32. Injection Pump

(2) Refer to paragraph 7-2 and disconnect inlet and fuel return lines from pump. Tag and disconnect high pressure lines at injector nozzle end at injector pump.

NOTE

All fuel connections must be plugged or capped to prevent contamination.

(3) Remove four hexagon nuts (2, figure 7-32), lockwashers (3), and flatwashers (4) holding pump (1) to crankcase and lift pump off crankcase. Be careful to retain the shims (5) between the crankcase and pump. The correct thickness of shims as stamped on the crankcase is important to proper pump operation; it provides the proper gear lash.

(4) When removing a pump for replacement, record the button thickness and port closing dimensions as stamped on the side of the pump mounting flange (figure 7-33). These values are important in timing a new pump to the engine.

b. Disassembly (see figure 7-34). All work on injection equipment MUST be performed in the cleanest location possible. No filing, scraping or sawing should be done on the bench where repairs are made.

(1) Clean all external dirt and grease from the pump.

CAUTION

The Pump Housing Must NEVER Be Clamped in a Vise.

NOTE

A special mounting fixture (see table 2-2) must be made to adequately secure the pump housing.

(2) Clamp the mounting fixture in a suitable vise.

(3) Install the pump into the mounting fixture, with two 0.3125"-18 UNC-HEX head screws.

(4) Release lock tabs (2) and remove the two control unit retaining plate screws (1) and tab washers (2, figure 7-34) and the control unit retaining plate and stop assembly (3). Carefully pull the control unit assembly (4) with plunger sleeve pin (5) out of the pump housing (6). Plunger sleeve pin occasionally may have to be removed separately. Use needle nose pliers or magnetic pencil.

(5) Remove the delivery valve cap nut (7) and gasket (8).

(6) Remove the delivery valve holder (9) then lift out the delivery valve spring (10), delivery valve assembly (11) and delivery valve spacer (12).

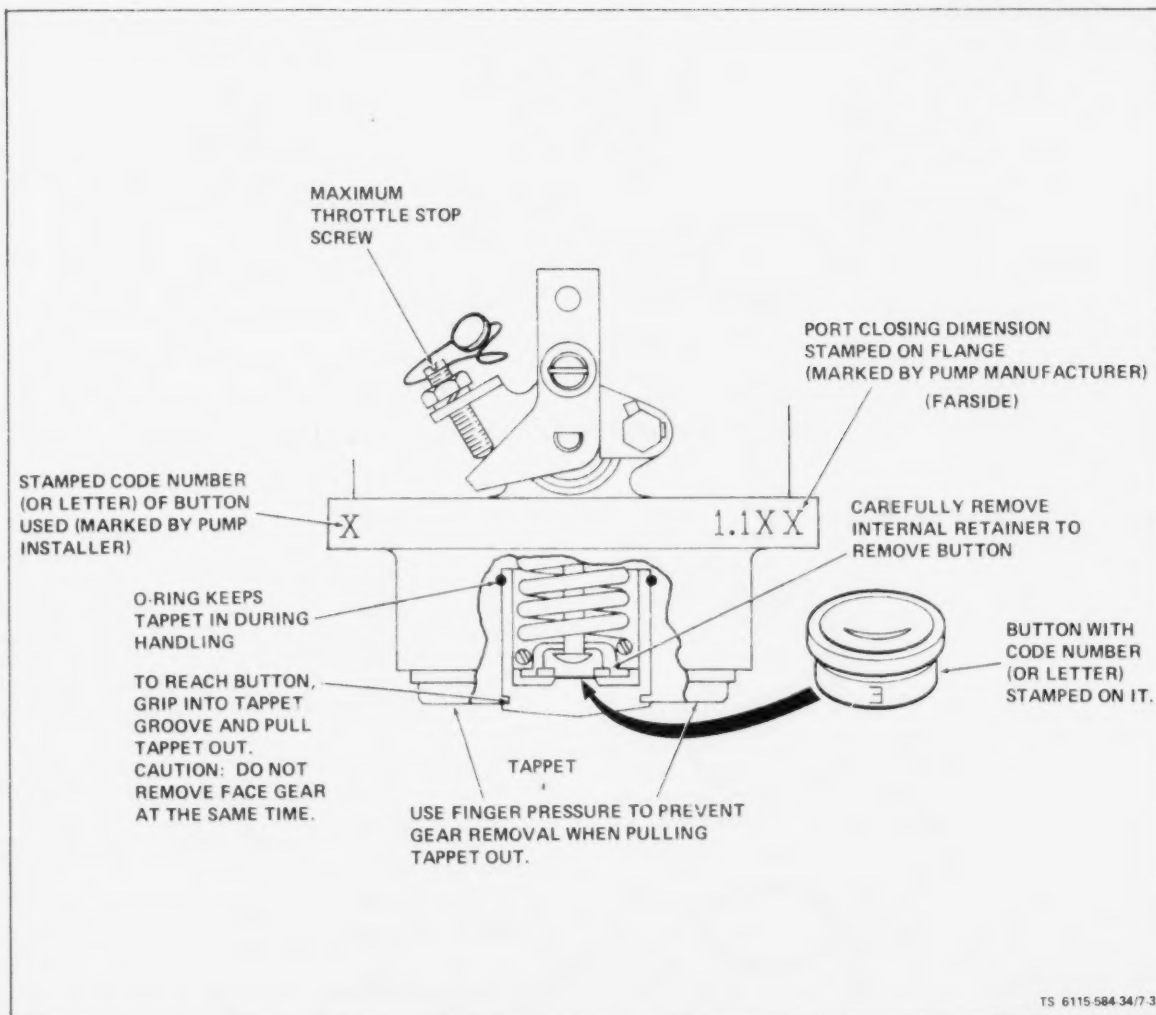
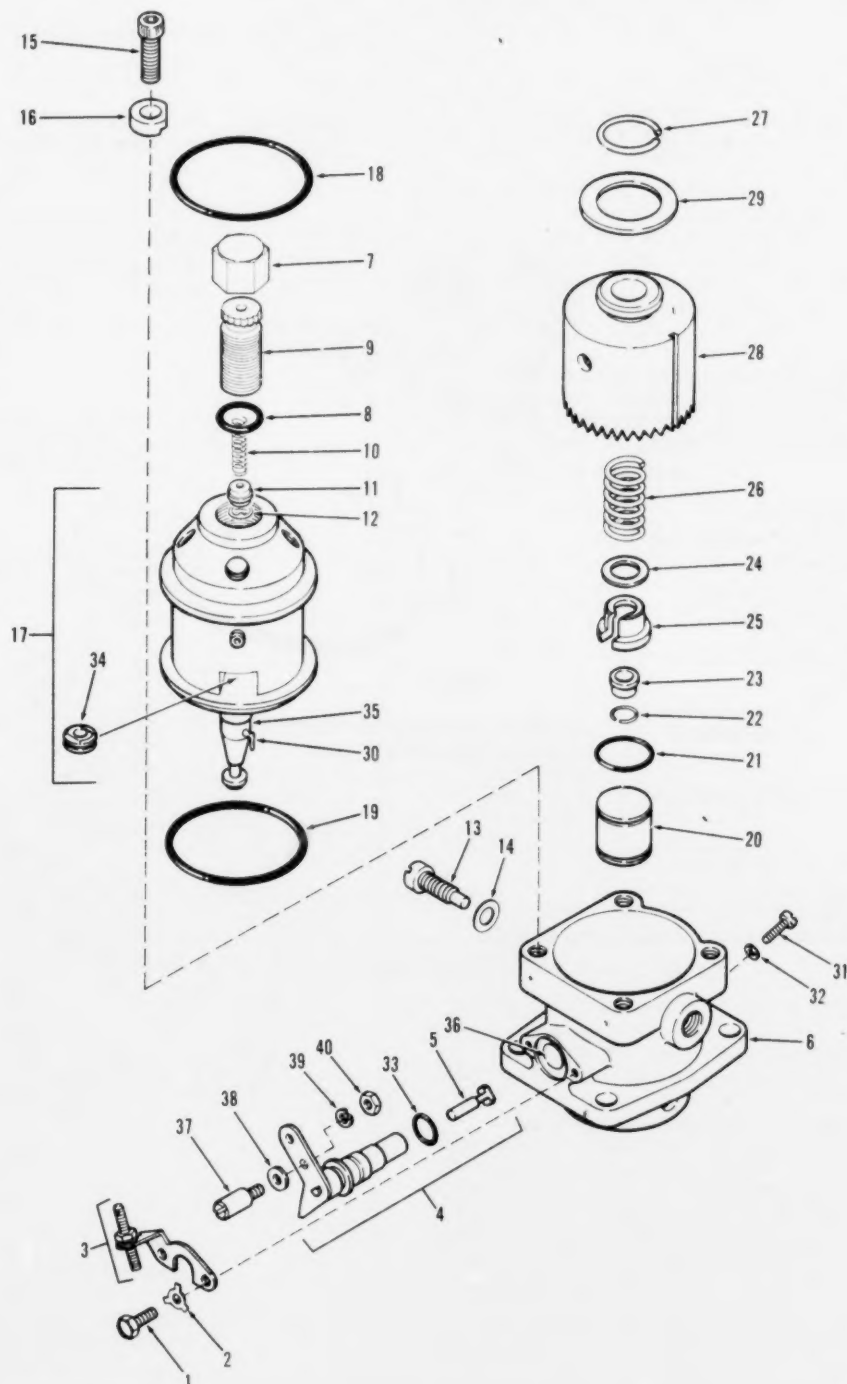


Figure 7-33. Injection Pump Adjustment and Button Removal

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Figure 7-34. Disassembly of Fuel Injection Pump (Sheet 1 of 2)

- | | | |
|---|-------------------------------|-----------------------|
| 1. Retaining plate screw (2) | 14. Copper gasket | 27. Spring ring |
| 2. Tab washer (2) | 15. Head retaining screws (4) | 28. Face gear |
| 3. Control unit retaining plate and stop assembly | 16. Head retaining clamps (4) | 29. Thrust washer |
| 4. Control unit assembly | 17. Head assembly | 30. Plunger drive pin |
| 5. Plunger sleeve pin | 18. Head "O" ring | 31. Timing screw |
| 6. Pump housing | 19. Head "O" ring | 32. Gasket |
| 7. Cap nut | 20. Tappet | 33. "O" ring |
| 8. Gasket | 21. "O" ring | 34. Plunger sleeve |
| 9. Delivery valve holder | 22. Button spring ring | 35. Plunger |
| 10. Valve spring | 23. Plunger button | 36. Control unit bore |
| 11. Delivery valve assembly | 24. Lower spring seat washer | 37. Pin |
| 12. Valve spacer | 25. Seat | 38. Flatwasher |
| 13. Locating screw | 26. Plunger spring | 39. Lockwasher |
| | | 40. Nut |

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Figure 7-34. Disassembly of Fuel Injection Pump (Sheet 2 of 2)

(7) Remove the hydraulic head locating screw (13) and copper gasket (14).

(8) Remove the four head retaining screws (15) and the four head retaining clamps (16). Carefully rest tappet on clean surface and using shaft head, hammer pump body assembly until hydraulic head assembly separates from body assembly.

(9) Remove the "O" rings (18 and 19) from the hydraulic head and the pump housing.

(10) Remove the tappet (20) and related "O" ring (21) from the face gear bore.

(11) Remove the spring ring (22) and the plunger button (23) from the end of the plunger (the plunger is part of hydraulic head assembly).

(12) Invert the hydraulic head assembly and place it in a suitable arbor press (see figure 7-35).

(13) Position tool TSE 76215 over the lower spring seat washer (24, figure 7-34) and depress the plunger spring, then remove the lower seat (25).

(14) Remove lower spring seat washer (24, figure 7-34) and plunger spring (26).

(15) Place the hydraulic head assembly on a bench. Using two screwdrivers to carefully pry off the face gear (28), then remove the thrust washer (29).

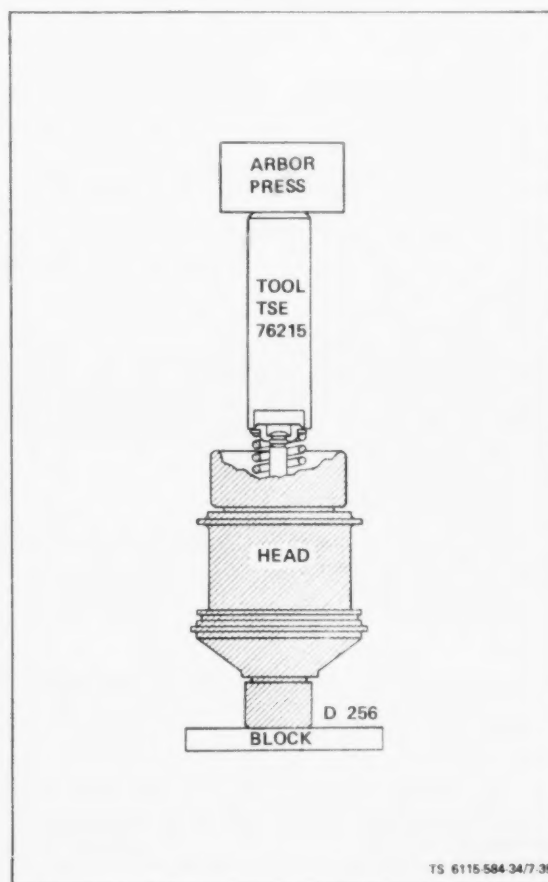
(16) Do not remove the plunger (35) out of the hydraulic head.

NOTE

The Plunger, Plunger Sleeve and Hydraulic Head are mated Parts and must ALWAYS be kept together.

c. Inspect (see figure 7-34).

(1) Place the delivery valve assembly in test fixture TSE 76226 and secure in a suitable vise (see figure 7-36).



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Figure 7-35. Removing Lower Spring Seat

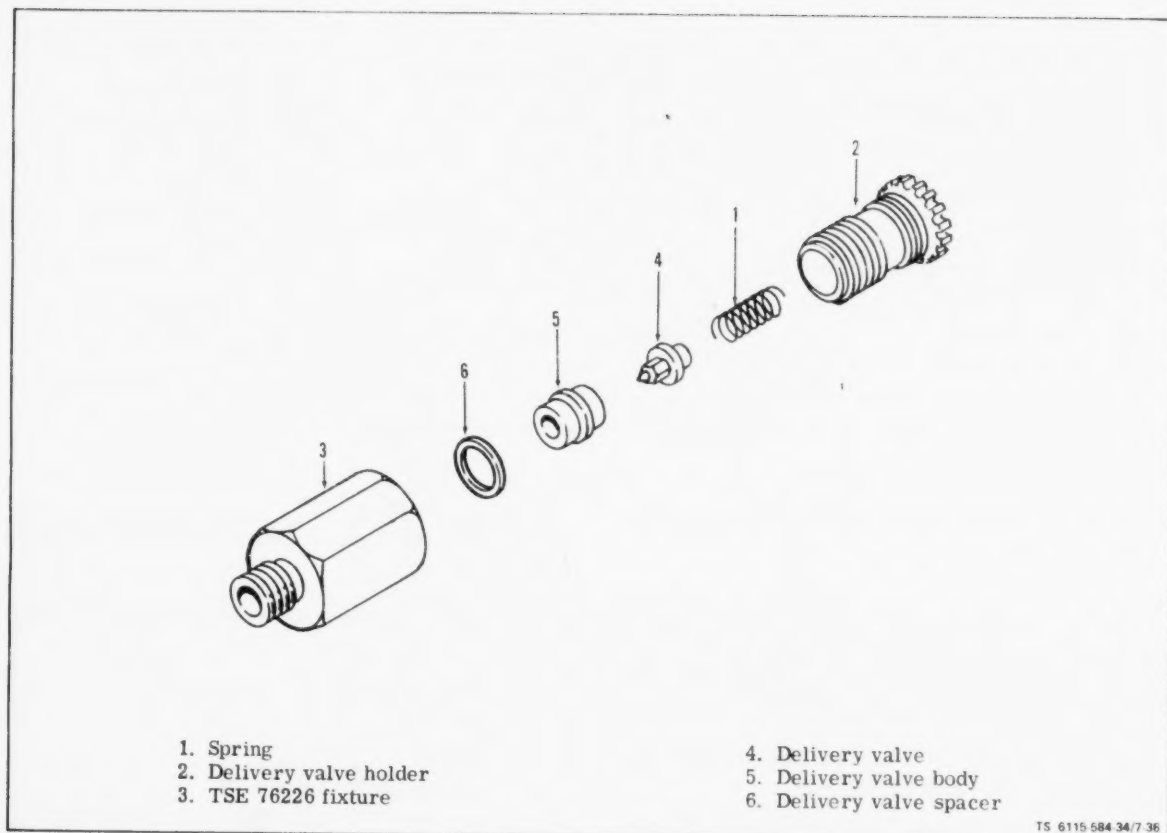


Figure 7-36. Delivery Valve Test Assembly

(a) Insert the delivery valve spring (1) and the delivery valve holder (2). Tighten the delivery valve holder to a torque of 70-75 ft-lbs. Figure 7-36 illustrates the components that are to be assembled to test fixture TSE 76226 (3).

(b) Attach test fixture TSE 76226 (3) to a manually operated Nozzle Test Stand.

NOTE

Always check to make certain that all external connections are tight and that the Nozzle Test Stand is in good order.

(c) Delivery valve opening pressure is 300-600 psi. Delivery valve must hold 275 psi for 30 seconds. Remove delivery valve assembly from test fixture. The delivery valve spring (1) must be free of nicks or wear (flat spots). Always replace nicked or worn springs.

CAUTION

LAPPING COMPOUND MUST NOT COME IN CONTACT WITH THE RELIEF PISTON DURING THE LAPPING OPERATION, AND ALL LAPPING COMPOUND MUST BE REMOVED BEFORE INSTALLING THE DELIVERY VALVE ASSEMBLY INTO THE HYDRAULIC HEAD.

(d) If the delivery valve assembly is leaky, the delivery valve seat may be lapped to its corresponding seat in the delivery valve body with a small quantity of suitable Lapping Compound.

(2) If the plunger button (23, figure 7-34) is grooved, ridged, scored, or exhibits an uneven wear pattern, it must be replaced.

(3) Install a thrust washer (29). Replace thrust washer if damaged.

(4) Replace the plunger drive gear (28) if the teeth are worn or damaged.

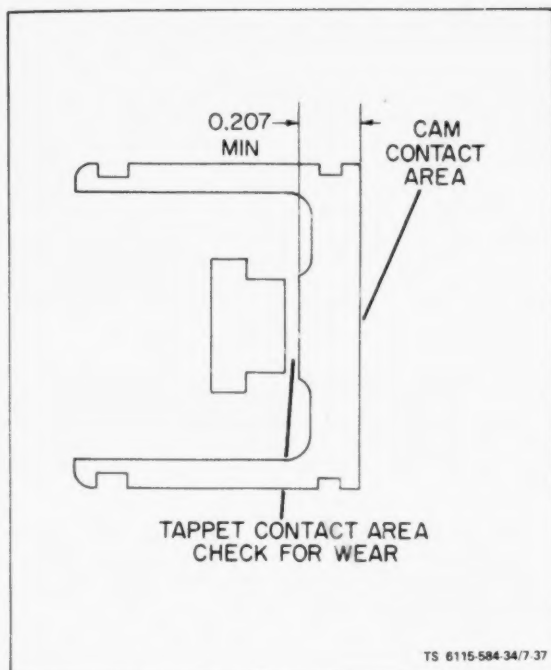


Figure 7-37. Inspecting Tappet

(5) Inspect the tappet (20) for possible wear at the contact areas. The primary contact areas are the tappet contact area and the cam contact area (figure 7-37). Replace the tappet if wear indentations exceed 0.002". The tappet thickness measured between the plunger button contact surface and the cam contact area must be 0.207" or larger.

(6) The pump housing (6, figure 7-34) should be washed in a cleaning solvent. Check all the screw threads in the housing, damaged threads can be repaired using thread inserts.

(7) Examine the pump housing for cracks or other damage which will cause oil leakage. Replace cracked housings.

NOTE

The control unit assembly is serviceable as a unit only. Each control unit assembly is furnished with a factory fitted plunger sleeve pin.

(8) Holding sleeve of control unit assembly (4), rotate lever; shaft must turn freely. If a binding condition exists, wash assembly in a cleaning agent, and repeat procedure. If binding condition is still present, control unit assembly must be replaced. Also check to make certain that weld holding lever to shaft is intact.

(9) The flat end of plunger sleeve pin (5) must be checked for clearance in the mating slot of the plunger sleeve. If the clearance is greater than 0.0015", the entire control unit must be replaced.

(10) Plunger sleeve pin (5) must fit snug but must be free to rotate in control unit assembly.

NOTE

New part clearance is 0.0002-0.0008". If clearance exceeds 0.0015", replace control unit assembly.

d. Reassembly (see figure 7-34).

NOTE

Replace all copper and "O" ring gaskets.

(1) After all parts have been thoroughly cleaned and inspected and after all worn units have been replaced, dip the individual parts in clean fuel oil.

(2) Invert the hydraulic head (17) and place it on a clean bench so that the head locating slot is forward.

(3) Refer to figure 7-38 and align the plunger drive pin (1) into the plunger (2) so that the head of the plunger drive pin is in the line with the distributor slot. Turn the plunger drive pin until its long side is parallel to the length of the plunger with long end up.

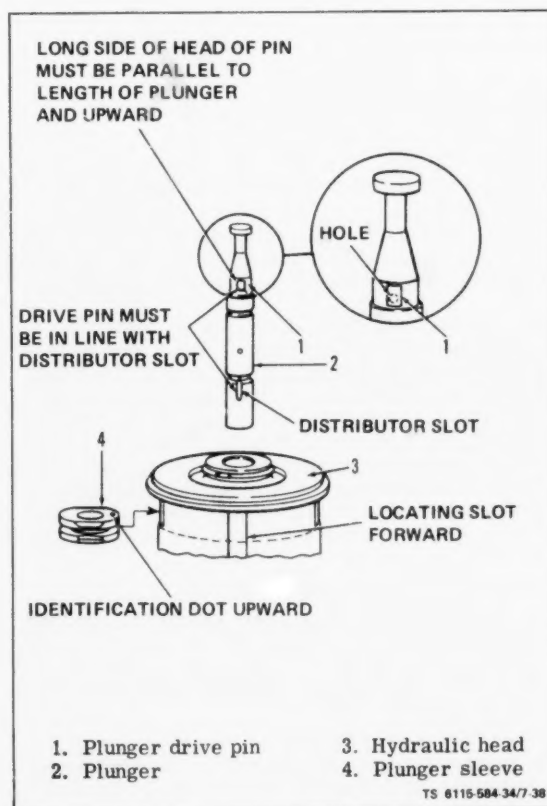


Figure 7-38. Assembling Hydraulic Head

(4) Apply a thin coat of petroleum jelly to the thrust washer (29, figure 7-34) and assemble it to the hub on the face gear (28).

(5) Carefully center spring ring (27) on hydraulic head assembly.

(6) Position the face gear (28) and thrust washer (29) over the end of the plunger and align the head of the plunger sleeve pin with its mating slot located on the inside of the face gear (28).

CAUTION

Do not use excessive pressure. If gear will not snap into place easily, remove gear and check to see that spring ring (27) is centered, and that plunger drive pin (1, figure 7-38) is properly aligned.

(7) Press the face gear (28, figure 7-34) onto the hydraulic head (17). Make certain that the spring ring (27) snaps into its mating groove in the face gear (28). Manually operate the plunger up and down. Free movement of the plunger indicates that the face gear has been correctly assembled to the hydraulic head.

(8) With head still in an inverted position, raise plunger (35) to its highest position.

(9) Apply grease to exposed position of plunger to keep it in its highest position.

(10) Install spring (26) and spring retaining washer (24), snap spring seat (25) into place on the plunger head (35).

(11) Install the plunger button (23) onto the end of the plunger and secure it by snapping the spring ring (22) into its mating groove in the lower spring seat (25).

(12) Check to make sure that the button spring ring (22) fits tightly into its groove in the lower spring seat (25). Loose spring rings (22) must be replaced.

(13) Apply a thin coat of petroleum jelly to the tappet "O" ring (21) and install it into its groove on the tappet (20). Apply thin coat of petroleum jelly to inside of tappet. Insert the tappet (20) into the face gear (28).

(14) Apply a thin coat of petroleum jelly to the hydraulic head "O" rings (18 and 19). Insert "O" ring into the head bore of the pump housing (6). Install the "O" ring into its groove on the upper portion of the hydraulic head. Ensure "O" rings seat properly.

(15) Clamp pump mounting fixture in a vise, install pump housing in fixture, then carefully insert the hydraulic head into the pump housing so that the locating slot in the hydraulic head is in line with the locating screw hole in the pump housing (not seating).

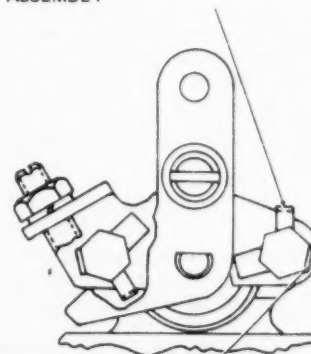
(16) Install the head locating screw gasket (14) and the head locating screw (13) into the locating screw hole in the pump housing (6). Slight repositioning of the hydraulic head may be necessary to properly install the head locating screw. DO NOT USE FORCE. Tighten screw (13) to a torque of 90 to 100 inch-pound. Install head retaining clamps (16) and screws (15). Alternately tighten screws (15) at opposite corners of housing (6) to properly seat the head assembly (17) in the housing. Tighten screws (15) to 13 to 15 ft-lbs. Insert the timing screw (31) and its gasket (32) into the timing screw hole in the pump housing. Tighten the timing screw to a torque of 20 to 25 inch-pounds.

(17) Install the delivery valve spacer (12), delivery valve assembly (11), delivery valve spring (10) and delivery valve holder (9), tighten delivery valve holder to a torque of 70-75 ft-lbs. Install delivery valve cap nut (7) and gasket (8). Torque nut to 55-60 ft-lbs.

(18) Insert pin (37, figure 7-34) and flatwasher (38) into lower hole of lever on control unit assembly (4) and secure with lockwasher (39) and nut (40). Tighten to 20-25 inch-pounds.

(19) Apply a film of grease, LU 3003, to the control unit "O" ring (33, figure 7-34), then install "O" ring in groove in control unit assembly. Ensure that "O" ring is seated. Apply oil to plunger sleeve pin (5) and insert the plunger sleeve pin (5) into the control unit assembly (4).

"BENT OVER" TAB MUST BE HELD AGAINST PLATE, AS SHOWN, DURING TORQUEING AT ASSEMBLY



BEND OVER ONE TAB AGAINST SIDE OF SCREW HEAD

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Figure 7-39. Control Unit Assembly

(20) Place pump in horizontal position with control unit bore (36) facing up.

(21) Center the plunger sleeve (34) in the control unit bore (36). Position plunger sleeve pin (5) so that the flats align with the groove in the control sleeve (34) and the electric pencil mark (dot) faces the top of the pump.

(22) Insert control unit assembly (4) into housing (6), pressing gently until control unit seats.

CAUTION

Do not use force. If flange is not seated on pump housing, rotate arm both ways with finger pressure pushing control unit in.

NOTE

Rotate the control unit lever through a 360° arc to make certain that the control unit assembly is correctly installed. Failure to rotate 360° indicates that the plunger sleeve pin (5) is not engaging the plunger sleeve slot.

(23) Install control unit assembly retaining plate, as shown in figure 7-39 using two tab washers and two screws. Torque screws to 20-25 inch-pounds and bend locking tabs over screws.

NOTE

If control unit will not seat, pull it out and repeat steps (20) through (22).

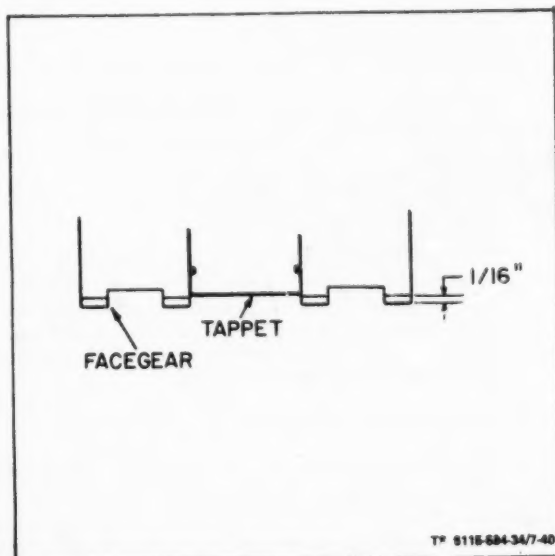


Figure 7-40. Checking Plunger Sleeve Alignment

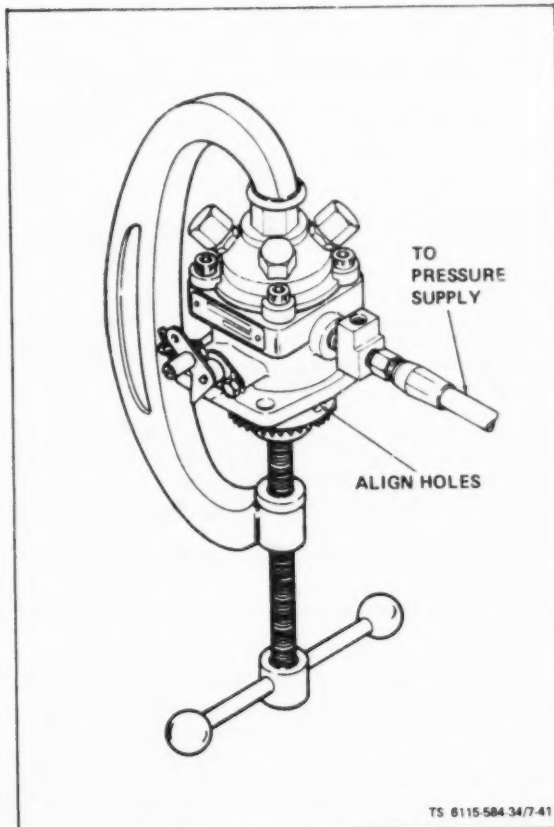


Figure 7-41. Pressure Testing Injection Pump

e. Test.

(1) Turn pump upside down and depress tappet with thumb. Tappet should recede 1/16" into face gear (figure 7-40). If tappet cannot be depressed 1/16" into face gear, plunger sleeve pin (5, figure 7-34) is improperly aligned. Disassemble pump and re-align pin.

(2) Remove the overflow valve assembly from the fuel outlet hole in the pump housing. Install a 1/4" pipe plug into the fuel outlet hole.

(3) Secure the pump close to a Nozzle Test Stand.

(4) Cap outlet ports (see figure 7-41).

(5) Install C-clamp on injection pumps as shown in figure 7-41 to retain face gear.

(6) Align holes in face gear and housing (see figure 7-41).

(7) Connect the Nozzle Test Stand to the fuel inlet hole in the pump housing.

NOTE

A fuel inlet stud can be fabricated with a 1/4"-18 NPT pipe die. High pressure tubing must be used between the Nozzle Test Stand and the pump assembly.

NOTE

Always check to make sure that all external connections are tight and that the Nozzle Test Stand is in good order.

(8) Slowly operate the Nozzle Test Stand until a pressure of 400 psi is achieved. A rapid drop in pressure indicates that a leak is present. The pressure must remain above 250 psi for at least 30 seconds.

WARNING

DO NOT EXCEED A PRESSURE OF 400 PSI.

(9) Visual inspection should be as follows:

(a) Check for leakage by the head locating screw (13, figure 7-34).

(b) Slight leakage by control unit shaft is normal and is necessary to lubricate shaft. Fuel leakage between the control unit body (4) and pump housing (6) indicates that either the "O" ring (33) is damaged or the mating surfaces are damaged. Replace the "O" ring (33) and retest the pump. If fuel leakage is excessive at control unit shaft or continues past "O" ring (33) replace defective parts.

(c) Check for leakage of fuel around the face gear (28). If leakage is evident, disassemble pump and inspect "O" ring (19).

(d) Check for fuel leakage between top of housing and head flange. To correct, disassemble and replace upper hydraulic head "O" ring (18).

f. Install.

(1) Turn engine flywheel to the port closing mark (PC) on the front cylinder (closest to blower wheel) compression stroke (see figure 7-44).

(2) Remove timing hole screw located on pump mounting flange (figure 7-42). Insert a 1/8 inch diameter wire into the hole.

(3) Rotate pump face gear until wire slips into place, locking the gear in position.

(4) Mount pump on crankcase (see figure 7-32) (be sure shims (5) are in place) and secure in position using four hexagon nuts (2), flatwashers (4) and lockwashers (3). If "O" ring seal between pump and crankcase is worn, cracked or otherwise defective, replace it.

(5) Remove wire. Install timing hole screw and copper gasket.

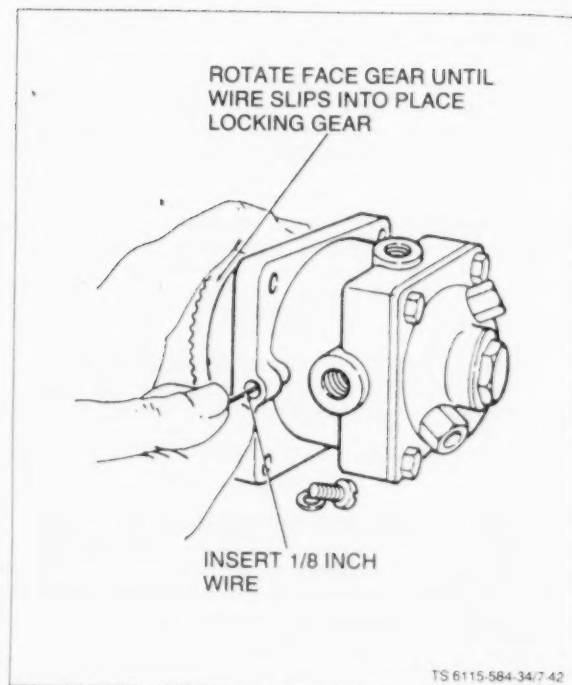


Figure 7-42. Injection Pump Installation

(6) If pump was not timed by method 1 below, time now using method 2 below.

(7) Connect flexible fuel inlet line to pump inlet. Connect fuel return line.

(8) Connect each fuel outlet line to the proper pump outlet (see paragraph 7-2).

(9) Connect governor linkage to governor arm.

(10) Start and run engine. Adjust governor linkage if required (see paragraph 7-3).

CAUTION

A maximum throttle stop screw, located on the injection pump control assembly, limits the maximum amount of fuel which can be injected into the engine. This screw should not be tampered with; it has been properly adjusted at the factory to protect the engine from over-fueling (see figure 7-33).

g. Adjust/Time on Equipment.

(1) Time the injection pump to the engine by using the proper thickness timing button between pump plunger and tappet (see figure 7-33). Use method 1 when replacing an old pump if the port closing dimensions and bottom number of the old pump were recorded. Use method 2 if the dimensions are lost, an old pump is being timed, or when replacing either the camshaft or crankshaft.

(2) Timing Method 1. This is a means for calculating the correct button thickness before the pump is installed. It requires the port closing dimensions and button thickness from the pump being replaced. Substitute the dimensions for those in the formula below and calculate the new button thickness. Determine the button code letter from table 7-1.

Example Formula:

Port closing dimension of old pump (removed from engine)	1.093
Button thickness of old pump	+0.119
	1.212
Port closing dimension of new pump	-1.089
Button thickness of new pump	0.123

Use button M

NOTE

Always use button thickness closest to this dimension.

Install the correct button in pump (figure 7-33) and install pump following the instructions under injection pump installation above.

(3) Timing Method 2. Flowing the Pump.

(a) Install a Number 12 or M timing button in injection pump and install pump on engine, following instructions under injection pump installation above.

CAUTION

When removing tappets which contain timing buttons, do not allow the portion of the injection pump which has the face gear to be lifted from its position.

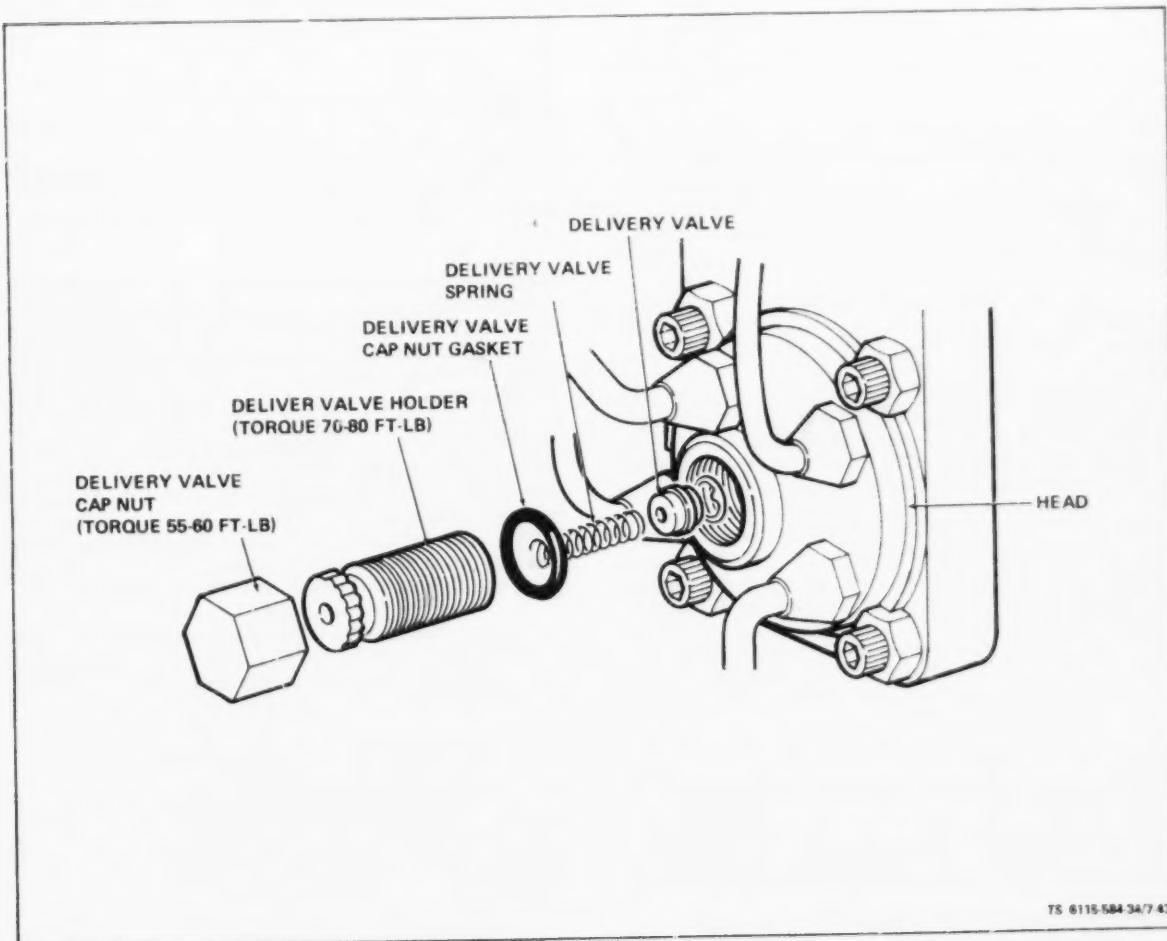


Figure 7-43. Delivery Valve

Table 7-1. Button Code Letter and Size

Code			Part No.	Size
No.	Or	Letter		
16		S	147A186	0.134
15		R	147A187	0.131
14		P	147A188	0.128
13		N	147A189	0.125
12		M	147A190	0.122
1		A	147A147	0.119
2		B	147A148	0.116
3		C	147A149	0.113
4		D	147A150	0.110
5		E	147A151	0.107

(b) Remove delivery valve cap nut and delivery valve holder (figure 7-43). A 12 point socket or box wrench must be used on delivery valve holder to keep from damaging this part. Lift out delivery valve spring only, and leave it out, replacing delivery valve holder, and delivery valve cap nut and gasket.

(c) Turn blower wheel clockwise until Number 1 cylinder (closest to blower wheel) is on compression stroke, which follows closing of intake valve.

(d) Set throttle lever on injection pump to wide open or up position (compress stop solenoid plunger spring or remove stop solenoid assembly). Connect Number 1 cylinder fuel line to Number 1 pump outlet so that fuel line projects from the engine, hanging down. Position receptacle for fuel under the line. Connect lines from fuel supply to transfer pumps, transfer pumps to filter, and filter to injection pump, operate fuel transfer pumps to obtain fuel pressure at injection pump. This can be done on the unit by turning master switch to PRIME & RUN, or just by applying 24 volts dc across the transfer pump. Rotate blower wheel about one inch counterclockwise so that P.C. mark is below timing pointer hole.

(e) Rotate blower wheel clockwise until fuel flows from Number 1 cylinder fuel line. Continue rotating slowly clockwise until fuel stops flowing. The point at which fuel stops flowing from Number 1 cylinder fuel delivery line is the injection pump port closing point. Stop rotation of engine at exactly the port closing point (1-2 drops in 5-10 seconds).

(f) Check timing pointer in the timing port on the side of the generator adapter (figure 7-44). If

7-40

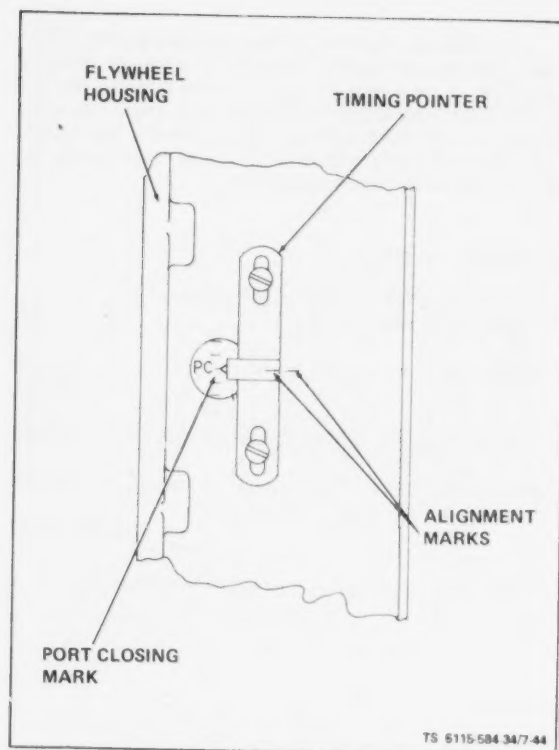


Figure 7-44. Timing Port and Port Closing Mark

timing pointer coincides with the P.C. mark stamped on flywheel, the injection pump button thickness is correct. If the P.C. mark on flywheel is below the pointer, injection pump is closing early, and will require a thinner button. If the P.C. mark on flywheel is above the pointer, injection pump is closing late and will require a thicker button. Each mark on flywheel indicates a difference of 0.006 inch button thickness or 2 steps in button code number. (Example: The P.C. mark on flywheel is above pointer. The pointer indicates 1-1/2 marks difference. A button 0.009 inch thicker or 3 steps difference in button number code is indicated. Since a Number 12 or M button is installed, a letter R button is needed.)

(g) Remove injection pump and insert proper timing button, taking the same precautions not to lift the assembly containing face gear, when removing timing button.

(h) Repeat injection pump installation.

(i) Check injection port closing point by repeating steps three through six. The timing pointer should indicate the P.C. mark on flywheel. In no case should pointer be more than 1/2 mark away from the P.C. mark.

(j) Install delivery valve components. Be sure all parts are clean, and assembled carefully and

properly. The delivery valve holder must be assembled with a twelve point wrench, and retorqued to 70-80 ft-lbs. The cap nut must be retorqued to 55-60 ft-lbs.

7-19. CYLINDER BLOCK.

a. Clean and Inspect.

(1) Steam clean cylinder block to remove deposits of oil and dirt. Immerse block in solvent tank to clean out internal passages.

(2) Inspect top surface of cylinder block, the surface that mates with the cylinder head, for warping. Check both across cylinders and in line with cylinder.

(3) Use magnetic particle method to check the cylinder block for cracks. Replace block if cracked.

(4) Cylinder walls should be free of scratches, pitting and scuffing. Check each cylinder with an inside reading micrometer for out-of-round and wear. See Table 1-2 for bore measurements.

b. Overhaul and Rebuild. Always de-glaze cylinder walls. If necessary, hone or rebore the cylinder to fit the next available oversize piston. Pistons and rings are available in 0.005, 0.010, 0.020, 0.030 and 0.040 inch oversize. If cylinders do not need re-finishing, remove any existing ridges from top of wall with a fine stone.

c. Install. If the cylinder block requires replacement a new set of injection pump shims must be used and the injection pump must be re-timed. The shims are supplied with the replacement cylinder block.

7-20. FUEL INJECTOR.

CAUTION

All injector openings and injector nozzles must be capped when the injector is removed from the engine.

a. Removal.

(1) Remove fuel lines (3 and 7, figure 7-1) at fuel injectors.

(2) Remove screws (1, figure 7-45), washers (2) and retaining flanges (3).

(3) Remove fuel injector (4), gasket (5), adapter (6), gasket (7), heat shield (8) and gasket (9). Separate injector from other components.

CAUTION

Do not attempt to disassemble nozzles or adjust nozzle pressure without the proper test equipment. A nozzle pressure tester is essential to do this work.

WARNING

Do not allow nozzle to spray against skin. Fuel under nozzle pressure can penetrate flesh and cause a serious infection.

b. Test. Install nozzle to be tested on a static fuel nozzle testing fixture. Increase fuel pressure until nozzle opens. Opening pressure should be 1950 ± 25 psi for a new nozzle or 1750 ± 25 psi for a used nozzle (200 hours or more). If nozzle opening pressure is lower, adjust to 1950 psi for a new nozzle or 1750 psi for a used nozzle (see adjustment procedure).

c. Adjust.

(1) Remove pipe plug (1, figure 7-46).

(2) Loosen (do not remove) cover (2).

(3) Install injector nozzle on a static fuel nozzle testing fixture.

(4) Insert a 5/32 inch hex socket key through hole in cover (2).

(5) Adjust opening pressure with hex key to correct pressure (1750 psi for a used injector, 1950 psi for a new injector).

(6) Tighten cover (2), and recheck opening pressure.

d. Disassemble.

NOTE

When removing and disassembling fuel injectors, separate and label components of each injector. Never interchange components of injectors.

CAUTION

Never clamp injector in a vise without soft jaws.

(1) Secure injector in a holding fixture and remove nozzle cap nut (12, figure 7-46) and nozzle (9).

NOTE

Do not remove nozzle unless replacement is required.

(2) Install nozzle cap nut (12) loosely to protect lapped surfaces of injector body.

e. Clean. Clean injectors in a clean room on a clean work bench. Provide a pan of clean diesel fuel and a supply of lint-free wiping cloths. Never use hard or

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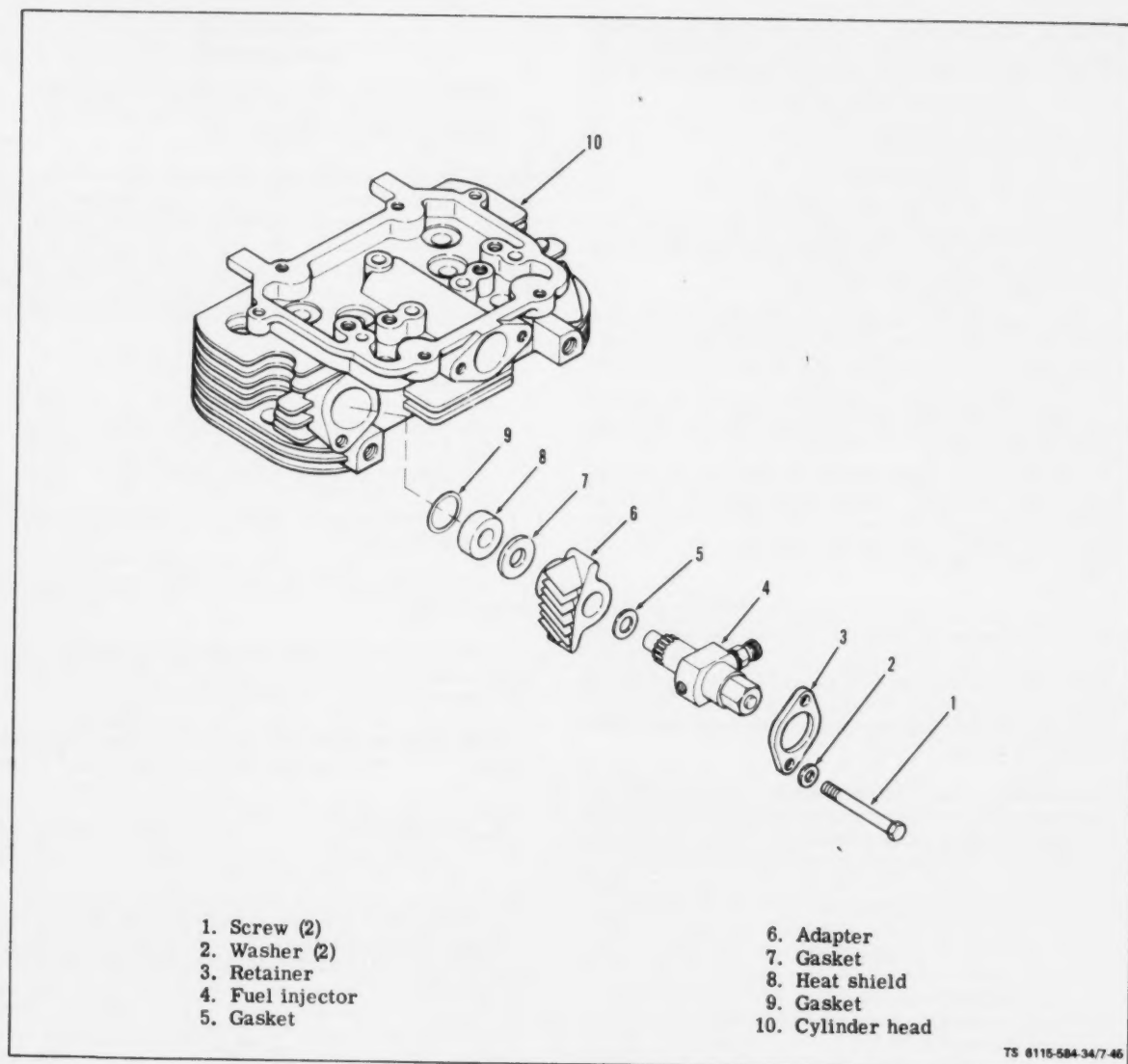


Figure 7-45. Injector Nozzle Removal

sharp tools, emery paper, grinding powder, or abrasives of any kind. If necessary, clean outer surfaces of nozzle body (9) with a brass brush but, do not attempt to scrape carbon from nozzle surfaces, because severe damage to spray hole can result. Use a soft, oil soaked cloth to clean nozzle valve. Clean interior of nozzle cap nut.

f. Inspect. Inspect tappet surfaces of injector body for nicks or roughening. If damaged, replace injector body.

g. Repair. If cleaning will not eliminate a nozzle defect, replace nozzle.

h. Assemble.

(1) Rinse valve (7, figure 7-46) and nozzle (9) thoroughly in clean fuel oil before assembly. Valve must be free in the nozzle. Lift valve (7) about one-third out of nozzle and release; valve should slide back to seat without aid when assembly is held at 45 degree angle. If necessary, work valve into nozzle body. Using dry compressed air, blow out fuel inlet (14).

(2) Remove all pressure on nozzle spring by loosening adjusting screw (3).

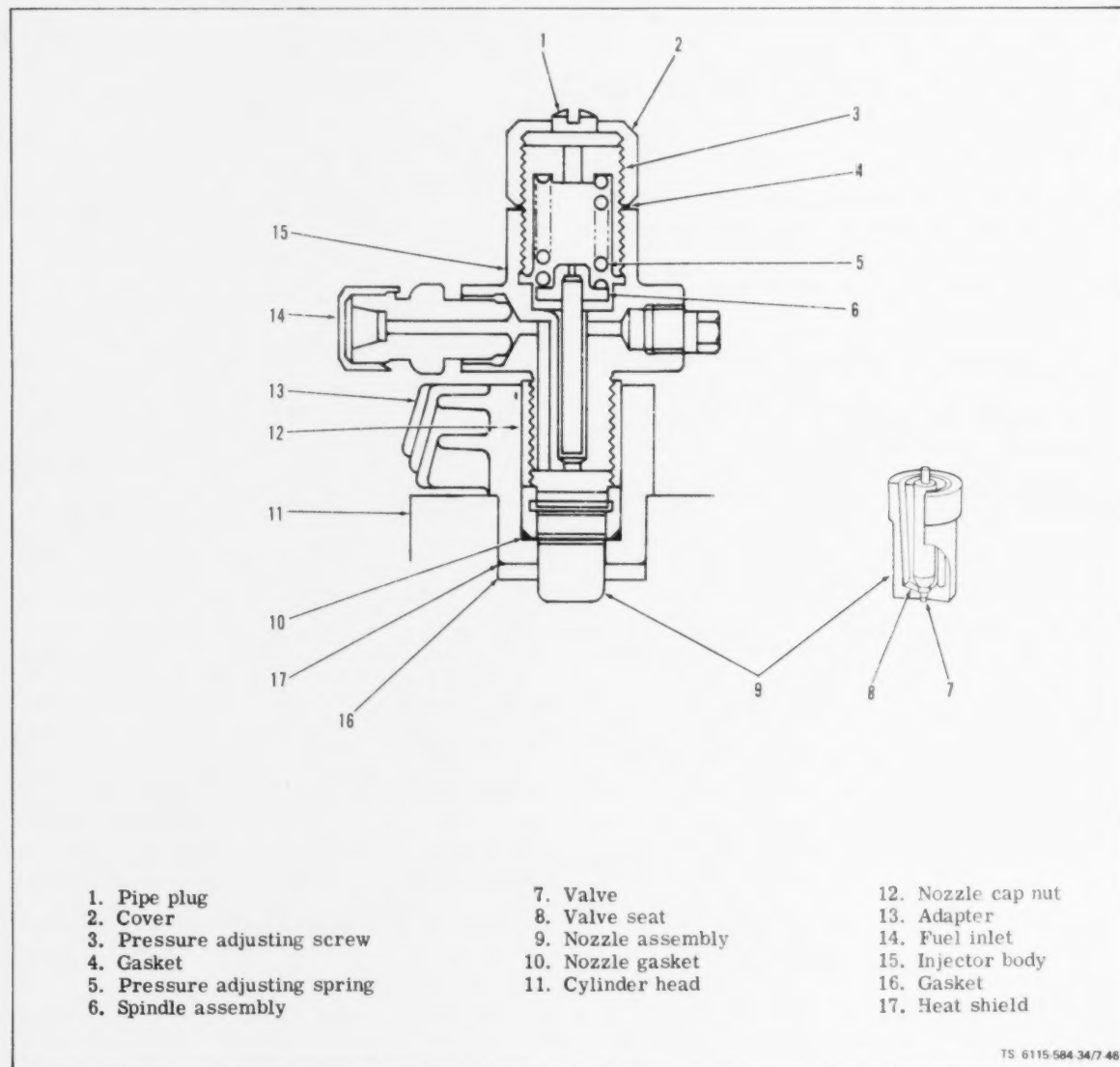


Figure 7-46. Fuel Injector

- (3) Mount injector in a suitable holding fixture.
- (4) Assemble valve (7) and nozzle (9) and install on body (15).
- (5) Install nozzle cap nut (12) loosely.

CAUTION

When tightening nozzle cap nut do not contact nozzle valve (7).

- (6) Place centering sleeve TSE 773 over nozzle for initial tightening. Remove centering sleeve after initial tightening to prevent it from binding between nozzle and cap nut and tighten nozzle cap nut to 50 to 55 ft-lbs.

- (7) Adjust opening pressure of nozzle (see paragraph 7-20c).

i. Installation.

- (1) Make sure old gasket material has been removed from injector.
- (2) Assemble new nozzle gasket (5, figure 7-45), adapter (6), gasket (7), heat shield (8) and gasket (9) on injector (4).
- (3) Install injector and assembled parts into cylinder head (10).
- (4) Install retaining flange (3) and tighten down with screws (1) and washers (2).
- (5) Reconnect fuel lines as described in paragraph 7-2.

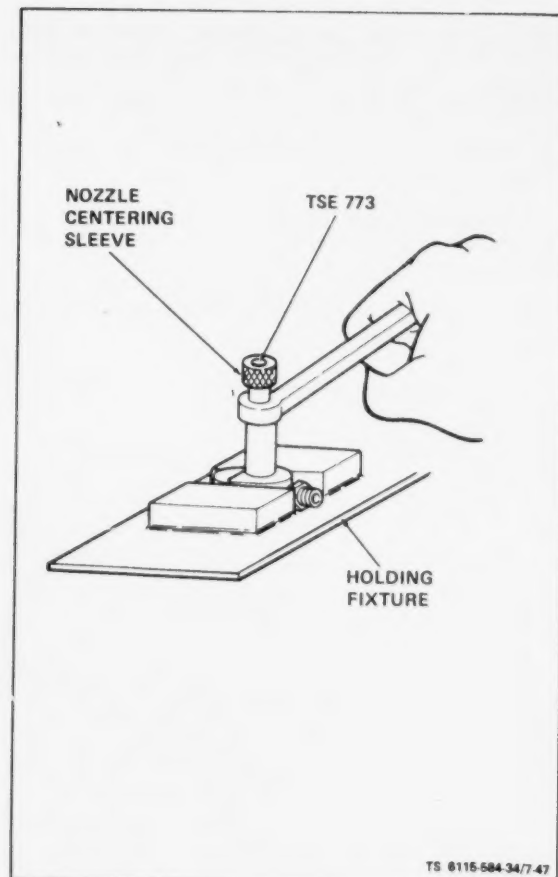


Figure 7-47. Centering Sleeve Installation

CHAPTER 8

MAINTENANCE OF GENERATOR ASSEMBLY

Section I. DESCRIPTION AND FUNCTION

8-1. GENERAL.

Refer to Operator and Organizational Maintenance Manual for description and function of the generator.

Section II. MAINTENANCE

8-2. GENERATOR MAINTENANCE.

a. Test (On Equipment) (see figure 8-1).

(1) Isolate the trouble to generator or regulator. Disconnect the voltage regulator at the exciter (wires P67C16 at TB3-5 and P60E16 at TB3-6). Connect a 12 volt battery in place of the regulator with the (+) terminal to TB3-6 and (-) terminal to TB3-5. Run the engine with the battery in place of the voltage regulator. If there is output now, the voltage regulator is bad. If there is no output, the main alternator is bad.

(2) Check generator operation. Run the set without an external load, if the engine appears to be loaded (dark smoke apparent) the generator may have a winding short to ground. If the engine does not seem to be loaded, there may be open windings.

(3) Testing Diodes (see figure 8-1). A shorted or open diode in the rotating rectifier assembly can cause bad generator operation. This is evident by failure of the generator terminal voltage to build up to rated value or a terminal voltage that is too low. When these symptoms are noticed, and the more obvious sources of trouble, (1) and (2) above have been eliminated, check the individual diodes of the rotating rectifier assembly as follows:

(a) Loosen four screws (5) and rotate bell cover (7) until it can be removed over screw heads.

(b) Disconnect each diode (42) by removing nuts and washers (40 and 41).

(c) Use an ohmmeter to measure the resistance between the terminal end and the threaded base (heat sink) end of the diode. Reverse ohmmeter leads and repeat the resistance measurement. A diode in good condition will have a very high resistance for one measurement and a resistance near zero when

ohmmeter probes are reversed. Failure to obtain these two extremes in resistance measurement indicates a defective diode that should be removed and replaced.

NOTE

Be sure points of ohmmeter probes are sufficiently long and sharp to penetrate any insulating varnish on diode terminals.

(4) Replacing Diodes. Diodes of the rotating rectifier assembly which are found to be defective or in questionable condition can be removed and replaced as follows:

(a) Unsolder wires from diodes.

(b) Install new diode and attaching hardware. Tighten nut (40, figure 8-1) only finger tight.

(c) Using a 25 to 40 watt soldering iron, solder leadwires to terminal of replaced diode. To protect diode from damage due to heat caused by soldering, hold diode terminal with needle nose pliers as a heat sink and use a low melting point solder.

(d) Allow each diode to cool after soldering. Tighten diode mounting nut (40) to torque of 30 inch-pounds.

(e) Install end bell cover (7).

(f) Tighten bolts (5).

(5) Resistance. Use resistance check to locate open circuits.

b. Removal. Refer to paragraph 2-10 for generator removal.

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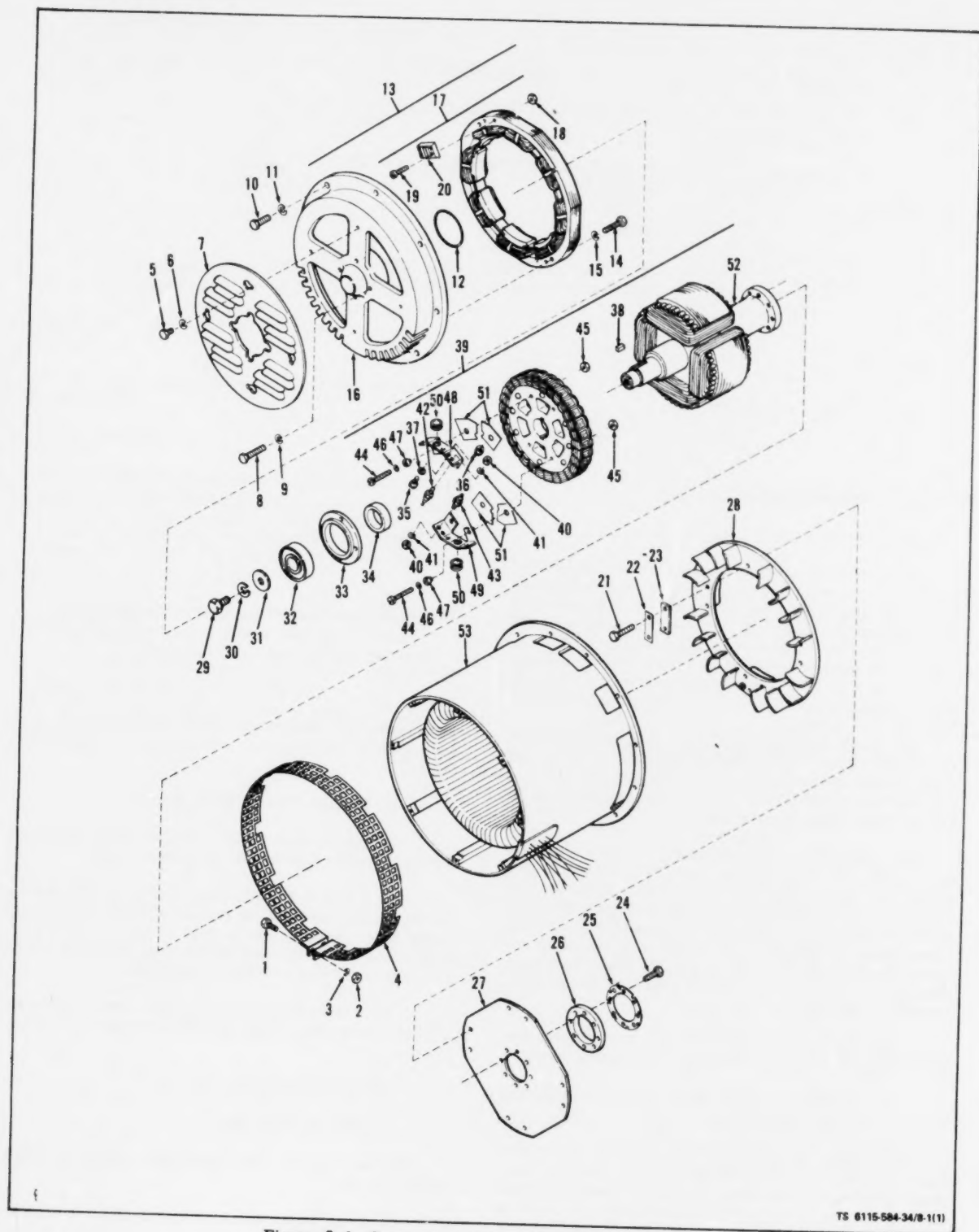


Figure 8-1. Generator Exploded View (Sheet 1 of 2)

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- | | | |
|-----------------------|------------------------|---------------------|
| 1. Screw (2) | 19. Screw (2) | 36. Nut (2) |
| 2. Nut (2) | 20. Terminal board | 37. Flatwasher |
| 3. Lockwasher (2) | 21. Screw (8) | 38. Key |
| 4. Screen | 22. Lock plate (4) | 39. Rotor assembly |
| 5. Screw (4) | 23. Pressure plate (4) | 40. Nut |
| 6. Lockwasher (4) | 24. Screw (8) | 41. Lockwasher |
| 7. Cover | 25. Lock plate | 42. Diode |
| 8. Screw (4) | 26. Ring | 43. Diode |
| 9. Lockwasher (4) | 27. Disk | 44. Screw (4) |
| 10. Screw (8) | 28. Fan | 45. Nut (4) |
| 11. Lockwasher (8) | 29. Screw | 46. Flatwasher (4) |
| 12. Packing | 30. Lockwasher | 47. Bushing (4) |
| 13. End bell assembly | 31. Flatwasher | 48. Heat sink |
| 14. Screw (4) | 32. Ball bearing | 49. Heat sink |
| 15. Lockwasher (4) | 33. Retainer | 50. Grommet (2) |
| 16. End bell | 34. Collar | 51. Insulator (4) |
| 17. Stator assembly | 35. Screw (2) | 52. Rotor |
| 18. Nut (2) | | 53. Stator assembly |

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Figure 8-1. Generator Exploded View (Sheet 2 of 2)

c. Disassembly (see figure 8-1).

(1) Remove screws (1), nut (2), lockwasher (3), attaching screen (4) to generator and remove screen.

(2) Remove screws (5), lockwashers (6), attaching end bell cover (7) to end bell and remove cover.

(3) Remove screws (8) and lockwashers (9) holding bearing retainer (33) to the end bell (16). Remove screws (10) and lockwashers (11) attaching end bell assembly (16) to stator assembly and remove end bell assembly.

(4) Remove "O" ring (12) from bearing housing. Remove and tag wiring harness from terminal board (20). Remove screws (19) and nuts (18) attaching terminal board to exciter stator and remove terminal board.

(5) Remove four screws (14) and lockwasher (15) attaching exciter stator (17) to end bell (16) and remove exciter stator.

(6) Remove eight screws (24) attaching coupling disk (27) to rotor shaft and remove coupling, lock plate (25) and retaining ring (26).

(7) Remove generator fan (28) which is now free. Do not remove balance screw from fan (28).

(8) Remove rotor assembly from stator assembly (53).

(9) Remove screw (29), lockwasher (30) and flatwasher (31) attaching bearing (32) to rotor shaft and remove bearing, bearing retainer (33) and shaft collar (34).

(10) If necessary, remove diodes from rotor as given in paragraph 8-2a above.

CAUTION

Do not remove exciter rotor from rotor shaft.

d. Inspect. Visually inspect windings and lead connections. Check that diodes are securely mounted on heat sinks. Clean dust, dirt, and grease from diodes. Clean windings and drain holes. Check that end bearing is not damaged or worn. Inspect cooling fan and coupling for damage.

e. Testing Exciter Stator (Field) (High Potential Test).

WARNING

Observe safety regulations. The voltages used in this test are dangerous to human life. Contact with the leads or the windings under test may cause severe, and possibly fatal, shock. Arrange the high voltage leads so that they are not in a position to be accidentally touched. Keep clear of all energized parts. Always reduce the test voltage to zero and ground the winding under test before making any mechanical or electrical adjustments on the equipment. When grounding out windings which have been tested, always connect the connection wire to ground first, and then to the winding. Never perform this test without at least one other person assisting. Generator frame shall be securely grounded.

(1) General. The high potential test is performed to determine whether or not the insulation of the equipment under test is defective. It is customary to determine whether electrical equipment will withstand normal voltage stresses by means of a test in which higher voltages than normal are applied for a definite

period of time. The applied voltage must not be so high as to injure the insulation unless the insulation was initially defective.

(2) Apparatus. Use acceptable high potential test apparatus, following the operating instructions of the manufacturer.

(3) Procedure.

(a) Adequately ground high potential apparatus to a water pipe or similar electrical ground in accordance with instructions accompanying the apparatus.

(b) Disconnect or remove rectifiers and semi-conductors from the circuit prior to conducting the tests.

(c) Isolate the rotor windings, the main stator windings, and the exciter stator windings. This is accomplished by disconnecting the various windings from any associated control circuits or other connections.

(d) Connect the high-voltage lead from the test apparatus to the winding or circuit under test. When testing stator rotor, all windings and circuits must be securely connected to ground. When testing rotor, all stator windings and circuits must be connected to ground.

(4) Test.

(a) Turn on test apparatus in accordance with manufacturer's instructions, after making sure that the initially applied voltage will be not greater than 600 volts.

(b) The test voltage then shall be raised uniformly to the required maximum. This increase shall be accomplished in not less than 10 seconds nor more than 30 seconds. The maximum test voltage for rotor windings shall be equal to 1,000 volts plus twice the highest rated voltage of the generator. The test voltage for stator windings shall be equal to 10 times for exciter ceiling voltage but in no case less than 1,500 volts nor more than 3,500 volts.

(c) Apply the maximum voltage for 1 minute.

(d) After 1 minute of applied maximum voltage, the voltage then shall be reduced gradually to the voltage initially applied. This reduction shall not be accomplished in less than 5 seconds.

(e) Turn off test apparatus. Ground the high-voltage lead of the test apparatus to make sure that no charge remains on the windings which have been under test.

(f) Remove the high-voltage lead from the winding and proceed with the tests of the remaining circuits to be tested. Make sure that all circuits not under test are securely grounded.

(5) Results. Any evidence of insulation breakdown is cause for replacement of the equipment under test.

f. Winding Resistance Test. Perform winding resistance test using a Wheatstone bridge. Follow the manufacturer's instructions given on the bridge. Resistance reading should be 36 ohms $\pm$ 3.6 ohms. Check resistance between each lead and frame. A low resistance shows that the stator is shorted.

g. Testing Exciter Rotor. Perform winding resistance test and high potential test per MIL-STD-705A, methods 401.1 and 302.1. Test between T₁-T₂, T₂-T₃, T₁-T₃. See figure 8-2 for location of test points. Resistance for each winding should be 0.677 ohms $\pm$ 0.067 ohms. Also test for shorts between windings and between each winding and rotor core.

h. Testing Generator Stator.

(1) High Potential Test. Test generator stator as given in paragraph 8-2e of this manual. Replace stator having faulty insulation.

(2) Winding Resistance Test. Perform winding resistance test using a Kelvin bridge. Follow the manufacturer's instructions given on the bridge. Resistance readings should be made on the pins of P9 and P10 (see figure 8-3). Resistance between lead pairs T₁-T₄, T₂-T₅, T₃-T₆, T₇-T₁₀, T₈-T₁₁ and T₉-T₁₂ should be 0.355 $\pm$ 0.036 ohms at 77° F (25° C). Refer to the table in figure 8-3 for location of the terminals. Also check resistance between each pin A through F of P9 and P10 and the stator frame. Low resistance indicates a shorted stator.

i. Testing Generator Rotor.

(1) High Potential Test. Test generator rotor as given in paragraph 8-2e of this manual. Replace rotor having faulty insulation.

(2) Winding Resistance Test. Perform winding resistance test using a Wheatstone bridge. Follow the manufacturer's instructions given on the bridge. Resistance reading should be 3.31 ohms $\pm$ 0.33 ohms. Check resistance between each lead and frame. A low resistance indicates that the rotor is shorted, a high resistance indicates open winding.

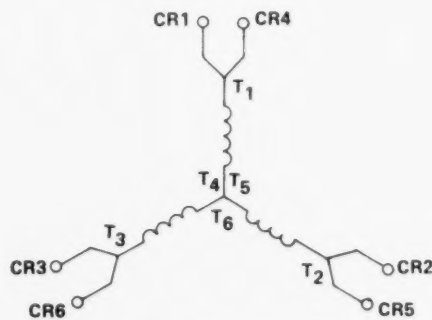
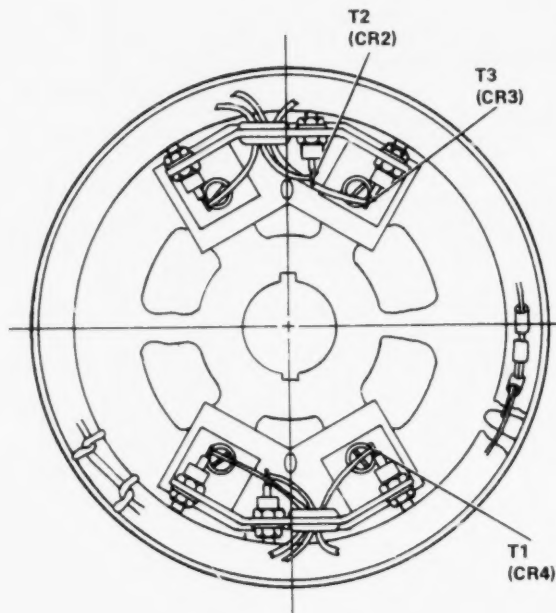
j. Reassembly.

(1) Install diodes (42 and 43, figure 8-1) on heat sink and secure with lockwashers (41) and nuts (40).

(2) Assemble shaft collar (34), bearing retainer (33), bearing (32) to the generator shaft using screw (29), lockwasher (30) and flatwasher (31).

(3) Place rotor assembly into stator (53).

(4) Position fan (28) in housing (53).



CONNECTION DIAGRAM

Figure 8-2. Testing Exciter Rotor

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(5) Mount coupling disc and fan assembly to the rotor assembly (52) using screw (24) lock plate (25) and retaining ring (26). Bend lock tabs flat against head of screw (24).

(6) Mount exciter stator (17) to end bell (16) using screws (14) and lockwashers (15).

(7) Place "O" ring (12) into end bell bearing housing, attach terminal board (20) to the exciter stator using screws (19) and nuts (18). Connect previously tagged and removed harness wire terminals.

(8) Mount end bell assembly (13) to the stator assembly (53) using screw (10) and lockwashers (11).

(9) Install bearing retainer (33) and secure to end bell (16) with lockwasher (9) and screw (8).

(10) Mount end bell cover (7) using screws (5) and lockwashers (6).

(11) Mount screen (4) to generator, secure with screw (1), nut (2) and lockwasher (3).

k. Test After Assembly. Rotate the generator rotor shaft to be certain it rotates freely, that bearings are smooth and rotor does not rub against stator.

l. Installation. Refer to paragraph 2-10 for mounting of the generator.

m. Generator Winding Data.

(1) Generator frame assembly (see figure 8-3).

(2) Generator rotor (see figure 8-5).

(3) Exciter rotor assembly (see figure 8-4).



CHAPTER 9

GENERATOR SET TEST AND INSPECTION AFTER REPAIR OR OVERHAUL

Section I. GENERAL REQUIREMENTS

9-1. GENERAL INFORMATION.

The activity performing the repair or overhaul is responsible for the performance of all applicable

tests and inspections specified herein. Activities performing maintenance on any portion of the Generator Set must perform those tests and inspections required by the applicable component or system repair instruction.

Section II. INSPECTION

9-2. GENERAL.

Inspecting entire unit for loose, missing, or damaged parts. Check that each part is properly painted and protected against corrosive climate conditions. Check that all parts are properly stowed on unit when not in use.

fan and blower housing and grille to prevent rubbing or binding. Check that shutter assembly operates freely, without binding.

9-3. ENGINE COOLING SYSTEM.

Check that all cooling system parts are in place. Check that there is sufficient clearance between engine

Inspect to see that all wiring harnesses are properly connected and that all connectors are tight. Check that all wires are secured away from moving parts which might damage wires.

9-4. WIRING HARNESSSES.

Section III. OPERATIONAL TESTS

9-5. GENERATOR AND GENERATOR CONTROL CIRCUITRY.

Test per table 9-1.

NOTE

Resistor R3 (20, figure 6-10) in the output control box, must be adjusted as follows before performing any tests:

a. Remove wire D26F16 from TB3-1 and connect 0 to 1 amp ac test ammeter as shown in figure 9-1.

b. Place output control switch in 120 10 position.

c. With the generator operating at rated speed (1800 RPM) the generator field can be flashed by placing the master switch on the control box in the start position.

d. Close the circuit interrupter and apply rated load.

e. Adjust R3 until ammeter previously installed reads 0.6 amps. Tighten locknut on R3. R3 is now adjusted properly.

f. Disconnect test equipment and proceed with testing in accordance with test schedule table 9-1.

9-6. ENGINE CONTROL CIRCUITRY.

a. Test Equipment.

(1) Batteries, 24 volts lead acid (BT1 and 2).

(2) Switch, SPST (S1, S2).

(3) Lamps, 24V (L1, L2, L3, L4, L5, L6, L7).

b. Test Setup. Connect control box and test equipment as shown in figure 9-2.

Table 9-1. Test Schedule

Test	Test Method (MIL-STD-705)	Requirements
Instrument	513.1C Record only the readings of the master and panel instruments at no-load, 50% and 100% of rated load. Record the readings of the master and panel instruments at all voltage connections.	Accuracy shall be as follows: Current indicator system, 10% max. Voltage indicator system - Initial accuracy 2.5% of full scale except that within the ranges of 115 to 125 and 200 to 250V. The error shall not exceed 3 and 5 volts respectively. Frequency indicator system 0.5% maximum. Voltage adjust range shall be between 197.6 and 218.4V for the 120/208V, 3 phase 4 wire connection between 114 and 125V for the 120V, 1 phase, 2 wire connection between 228 and 252V for the 120/240V, 1 phase, 3 wire connection.

c. Test Procedure.

- (1) Position switches as follows:
 - (a) Master switch-stop.
 - (b) Panel light switch-off.
 - (c) S1-closed.

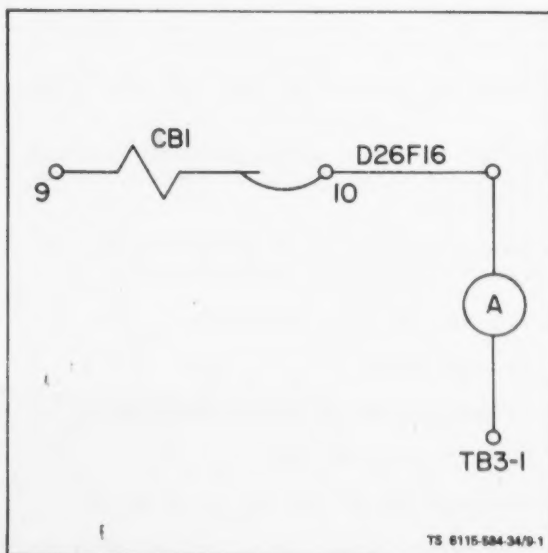


Figure 9-1. Adjusting R3 Resistor

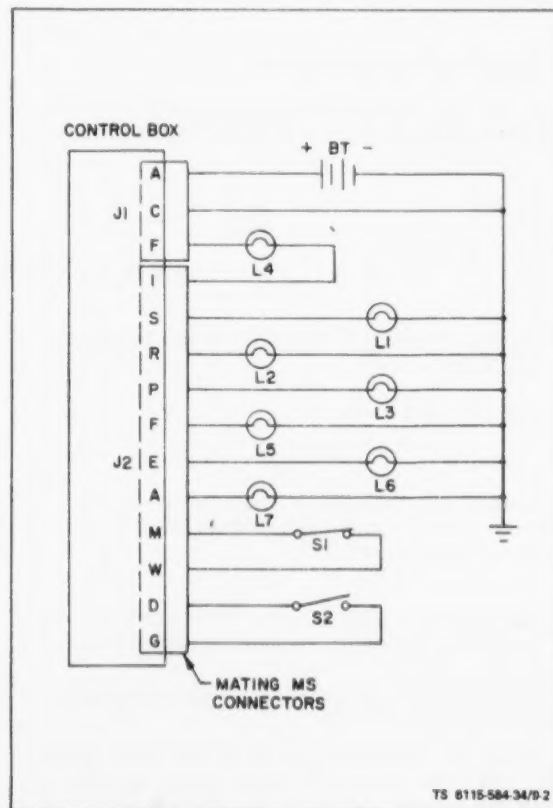


Figure 9-2. Testing Engine Control Circuitry

(d) S2-open.

(2) Place master switch in preheat position. Lamps L2 and L3 shall light indicating that the preheat circuitry is correct.

(3) Place master switch in start position. Lamps L1, L2, L3, L4, L5 and L6 shall light indicating that all circuits for starting are correct.

(4) With the master switch in the start position, open switch S1, lamp L1 shall extinguish indicating that the start disconnect circuitry is correct.

(5) With the master switch in the start position, close switch S2 and then place the master switch in the prime and run position. Lamps L2 and L3 shall extinguish lamps L4, L5 and L6 shall remain lit indicating that the prime and run circuitry are correct.

(6) With the master switch in the prime and run position and lamps L4, L5 and L6 lit, open switch S2. Lamp L4 shall extinguish indicating that the engine protective devices circuit and the prime circuit is correct.

(7) Repeat the procedure of step 5, except that the master switch shall be placed in the prime and run aux. fuel position after closing switch S2. Lamps L4, L5, L6, and L7 shall remain lit indicating that the prime and run aux. fuel circuitry is correct.

(8) With the master switch in the prime and run aux. fuel position and lamps L4, L5, L6 and L7 lit open switch S2. Lamp L4 shall extinguish indicating that the engine protective devices circuit and the prime circuit is correct.

(9) Place master switch in the stop position, all lamps shall be out indicating that all stop circuits are correct.

(10) Place panel light switch in the on position, panel lights shall be on indicating that the panel light circuit is correct.

(11) Reposition all switches as in step 1 and disconnect test setup.

APPENDIX A

REFERENCES

1. PAINTING:

T.O. 35-1-3 Painting and marking of USAF Aerospace Ground Equipment.

2. RADIO SUPPRESSION:

MIL-STD-461 Radio Interference Suppression.

3. MAINTENANCE:

T.O. 00-25-225 Repair of External Power Cables, Aerospace Ground Equipment.
T.O. 00-25-235 General Shop Practice Requirements for the Repair, Maintenance and Test of Electric Equipment.

T.O. 1-1-1 Cleaning of Aerospace Equipment.

T.O. 1-1-2 Corrosion Control and Treatment for Aerospace Equipment.

T.O. 31-1-75 General Maintenance Practices.

T.O. 35-1-11 Organization, Intermediate and Depot Level Maintenance for FSC 6115 Equipment.

T.O. 35-1-12 Components and Procedures for Cleaning Aerospace Ground Equipment.

T.O. 35-1-26 Repair/Replacement Criteria for FSC 6115 Aerospace Ground Equipment.

T.O. 35-1-524 USAF Equipment Registration Number System Applicable to FSC 6115 Equipment.

T.O. 34Y19-1-111 Electric Motor and Generator Repair.

AFM 66-1 AF Maintenance Management.

T.O. 35C2-3-1-426 Inspection and Maintenance of FSC 6115 Electrical Generator Set.

4. SHIPMENT AND STORAGE:

T.O. 35-1-4 Processing and Inspection of Aerospace Ground Equipment for Storage and Shipment.

T.O. 38-1-5 Processing and Inspection of Non-Mounted, Non-Aircraft Gasoline and Diesel Engines for Storage and Shipment.

5. DESTRUCTION OF MATERIAL:

TM 750-244-3 Procedures for Destruction of Equipment to Prevent Enemy Use.

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Distribution:

To be distributed in accordance with DA Form 12-25D, Direct and General Support maintenance requirements for Generator Sets, Engine Driven: 5 KW, 60 HZ.

PIN: 032781-000

REF DES & DESCRIPTIONS

A1	RELAY ASSY
A2	VR ASSY GEN
A3	TRIG SOLC
A4	BRIDGE ASSY
A5	VR ASSY ENG
A6	STARTER
B1	REAR 115 VOLT
C	CAPACITOR
C1	AC LCT BRKR
C2	AC RPT BRKR
D1	CONV SOL
D2	CONV SOL
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WIRING SCHEMATIC

The diagram shows a complex network of electrical connections between various components. Key components include:

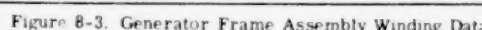
- Relays:** A1, A2, A3, A4, A5, A6, B1, C, C1, C2, D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, D16, D17, D18, D19, D20, D21, D22, D23, D24, D25, D26, D27, D28, D29, D30, D31, D32, D33, D34, D35, D36, D37, D38, D39, D40, D41, D42, D43, D44, D45, D46, D47, D48, D49, D50, D51, D52, D53, D54, D55, D56, D57, D58, D59, D60, D61, D62, D63, D64, D65, D66, D67, D68, D69, D70, D71, D72, D73, D74, D75, D76, D77, D78, D79, D80, D81, D82, D83, D84, D85, D86, D87, D88, D89, D90, D91, D92, D93, D94, D95, D96, D97, D98, D99, D100.
- Switches:** S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21, S22, S23, S24, S25, S26, S27, S28, S29, S30, S31, S32, S33, S34, S35, S36, S37, S38, S39, S40, S41, S42, S43, S44, S45, S46, S47, S48, S49, S50, S51, S52, S53, S54, S55, S56, S57, S58, S59, S60, S61, S62, S63, S64, S65, S66, S67, S68, S69, S70, S71, S72, S73, S74, S75, S76, S77, S78, S79, S80, S81, S82, S83, S84, S85, S86, S87, S88, S89, S90, S91, S92, S93, S94, S95, S96, S97, S98, S99, S100.
- Transformers:** T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13, T14, T15, T16, T17, T18, T19, T20, T21, T22, T23, T24, T25, T26, T27, T28, T29, T30, T31, T32, T33, T34, T35, T36, T37, T38, T39, T40, T41, T42, T43, T44, T45, T46, T47, T48, T49, T50, T51, T52, T53, T54, T55, T56, T57, T58, T59, T60, T61, T62, T63, T64, T65, T66, T67, T68, T69, T70, T71, T72, T73, T74, T75, T76, T77, T78, T79, T80, T81, T82, T83, T84, T85, T86, T87, T88, T89, T90, T91, T92, T93, T94, T95, T96, T97, T98, T99, T100.
- Other Components:** K1, K2, K3, K4, K5, K6, K7, K8, K9, K10, K11, K12, K13, K14, K15, K16, K17, K18, K19, K20, K21, K22, K23, K24, K25, K26, K27, K28, K29, K30, K31, K32, K33, K34, K35, K36, K37, K38, K39, K40, K41, K42, K43, K44, K45, K46, K47, K48, K49, K50, K51, K52, K53, K54, K55, K56, K57, K58, K59, K60, K61, K62, K63, K64, K65, K66, K67, K68, K69, K70, K71, K72, K73, K74, K75, K76, K77, K78, K79, K80, K81, K82, K83, K84, K85, K86, K87, K88, K89, K90, K91, K92, K93, K94, K95, K96, K97, K98, K99, K100.

TERMINAL CONNECTION TABLE

POSITION	TERMINALS CONNECTED
1	1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, 1-9, 1

Change 2 1-9/(1-10 blank)

TM 5-6115-584-3
NAVFAC P-8-622-34
TO-35C2-3-456-2
TM-0568C-34



8-7 / (8-8 blank)

TM 5-6115-584-34
NAVFAC P-8-622-34
TO-35C2-3-456-2
TM-0568C-34

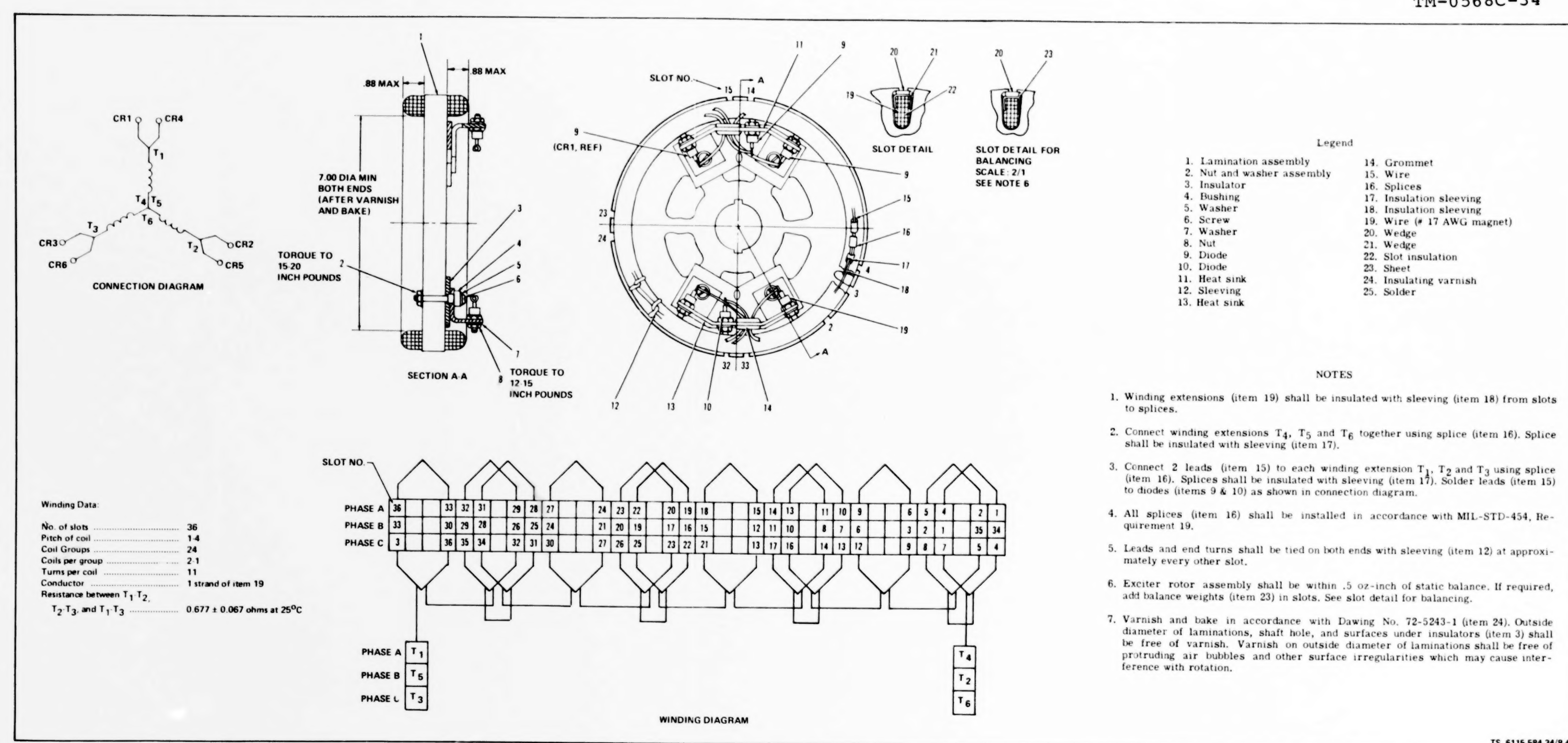


Figure 8-4. Exciter Rotor Assembly Winding Data

8-9/(8-10 blank)

TM 5-6115-584-34
 NAVFAC P-8-622-34
 TO-35C2-3-456-2
 TM-0568C-34

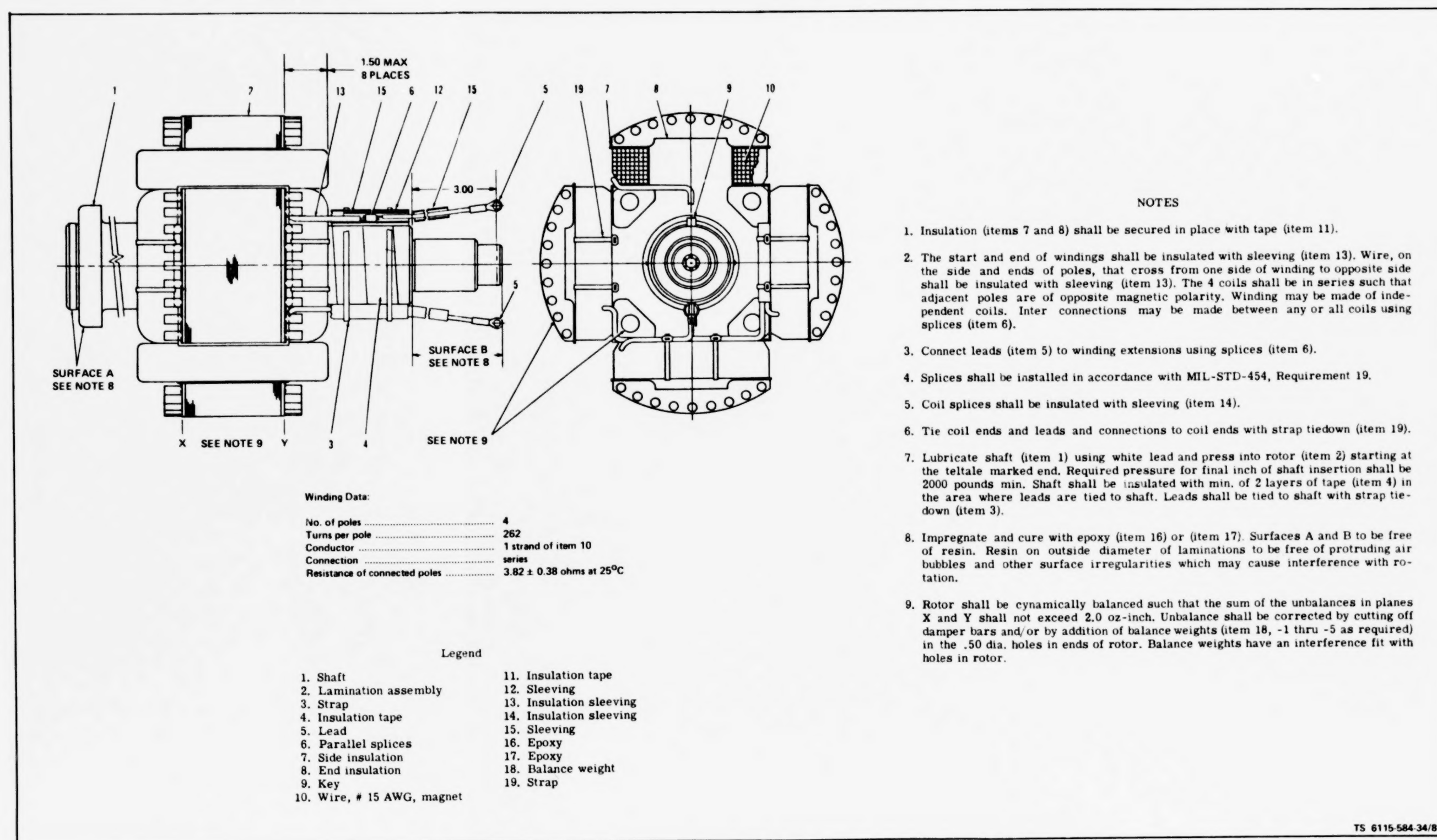


Figure 8-5. Generator Rotor Winding Data

8-11/ (8-12 blank)